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Seer Program

Self Instructional Manual for Tumor Registrars

Book Four Part II

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Book 4 - Human Anatomy as Related to Tumor Formation

Part II

Sections H - N

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Any changes between this edition and the March 1986 edition are indicated with a marker (|) and a note explaining the change so that you can update your 1986 copies.

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BOOK 4

Human Anatomy as Related to Tumor Formation

Part II

Sections H - N

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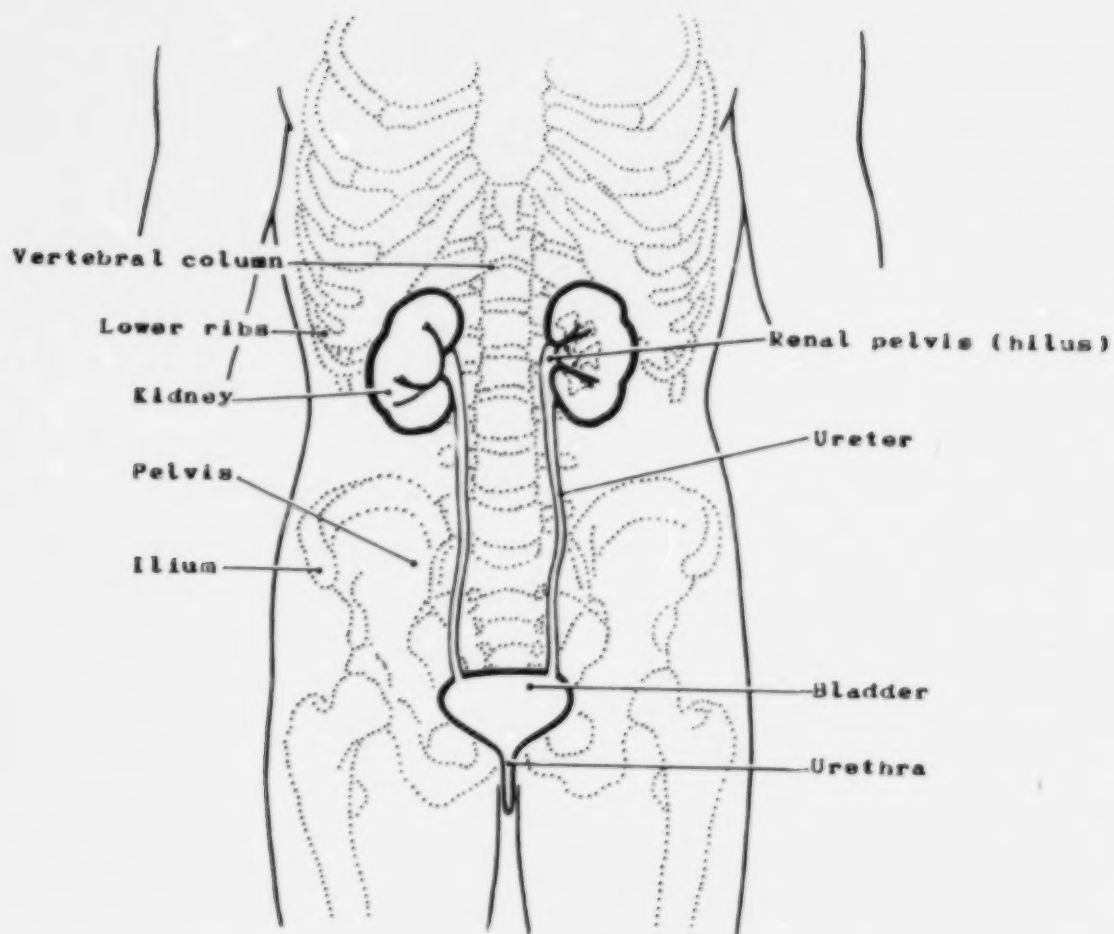
BOOK 4: HUMAN ANATOMY AS RELATED TO TUMOR FORMATION

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SECTION H
URINARY SYSTEM

Figure 1. PRINCIPAL PARTS OF THE URINARY SYSTEM



SECTION H

URINARY SYSTEM

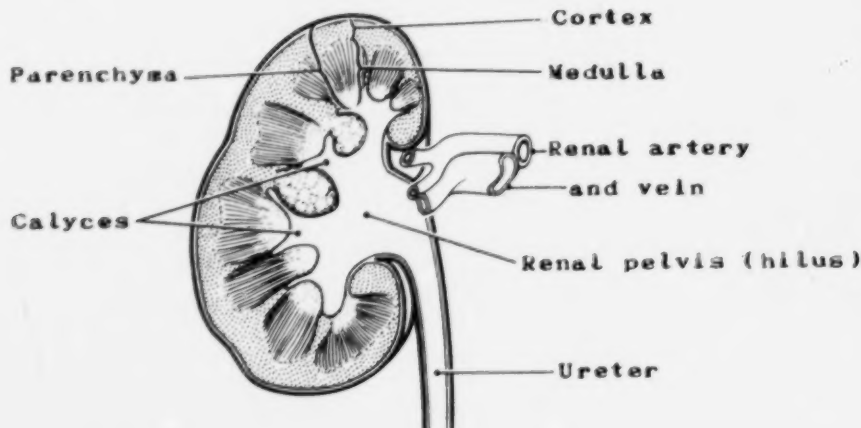
The urinary system in both males and females consists of two kidneys, two ureters, a urinary bladder, and a urethra. It is part of the excretory system of the body which also includes the respiratory, integumentary, and digestive systems.

Kidney

Each kidney is located lateral to the spinal column in the lumbar region behind the abdominal cavity. Each is, therefore, retro-peritoneal, or in back of the peritoneal cavity. Each is embedded in a mass of fatty tissue which is surrounded by a fibrous covering called the renal fascia or Gerota's fascia. The renal pelvis joins the kidney parenchyma at the hilus which is located on the inner, or medial, side of each kidney. The structures of the kidney parenchyma and kidney pelvis are quite different:

- The kidney parenchyma is the glandular part of the organ where the filtration of blood takes place and urine is produced. The outer connective tissue layer is called the cortex; the inner structure is called the medulla. The medulla consists of renal (medullary) pyramids which are separated from one another by extensions of the cortex into the medulla called renal columns.
- The renal pelvis and calyces collect the urine which is then transported by the ureters from the kidney to the urinary bladder for storage.

Figure 2. KIDNEY



parenchyma--the functional working elements of an organ

calyces--(plural of calyx)--cuplike organs or cavities

The microscopic structure of the renal pelvis is similar to that found in parts of the gastrointestinal tract as well as in the bladder and ureter (see page 20) and is as follows:

- **MUCOSA**

The EPITHELIAL LAYER contains no blood vessels or lymphatics.

The BASEMENT MEMBRANE is a sheet of extracellular material that functions as a filtration barrier and a boundary which helps to generate and maintain tissue structure.

- **LAMINA PROPRIA**, composed of areolar connective tissue, contains blood vessels, nerves, and, in some regions, glands. Once tumor has broken through the basement membrane into the lamina propria, it can spread by way of the lymphatics and blood vessels to the other parts of the body.

The urinary sites have NO MUSCULARIS MUCOSAE, and therefore, the lamina propria and the submucosa tend to merge; these terms will be used interchangeably.

- The SUBMUCOSA is a thick layer of connective tissue. It contains blood vessels, lymphatic vessels, nerves, and, in some regions, glands.
- The MUSCULARIS PROPRIA is composed of two layers of smooth muscle tissue; it constitutes the wall of the organ.
- There is no serosa on the renal pelvis or ureters. Where there is no serosa, the connective tissue of surrounding structures merges with the connective tissue of the organ and is called ADVENTITIA. It forms the outer covering of some other tubular structures such as the esophagus and the blood vessels.

Q1

The urinary system consists of two _____, two _____, a urinary _____, and a _____.

Q2

The kidneys are located in back of the peritoneal cavity or retro-peritoneally, specifically, lateral to the _____ in the _____ region behind the abdominal cavity.

Q3

The glandular (working) part of the kidney is called the _____, while the part of the kidney that collects the urine which is then transported by way of the ureter to the urinary bladder is called the _____.

Answer: Q1

The urinary system consists of two kidneys, two ureters, a urinary bladder, and a urethra.

Answer: Q2

The kidneys are located in back of the peritoneal cavity or retroperitoneally, specifically, lateral to the spinal column in the lumbar region behind the abdominal cavity.

Answer: Q3

The glandular (working) part of the kidney is called the parenchyma, while the part of the kidney that collects the urine which is then transported by way of the ureter to the urinary bladder is called the renal pelvis.

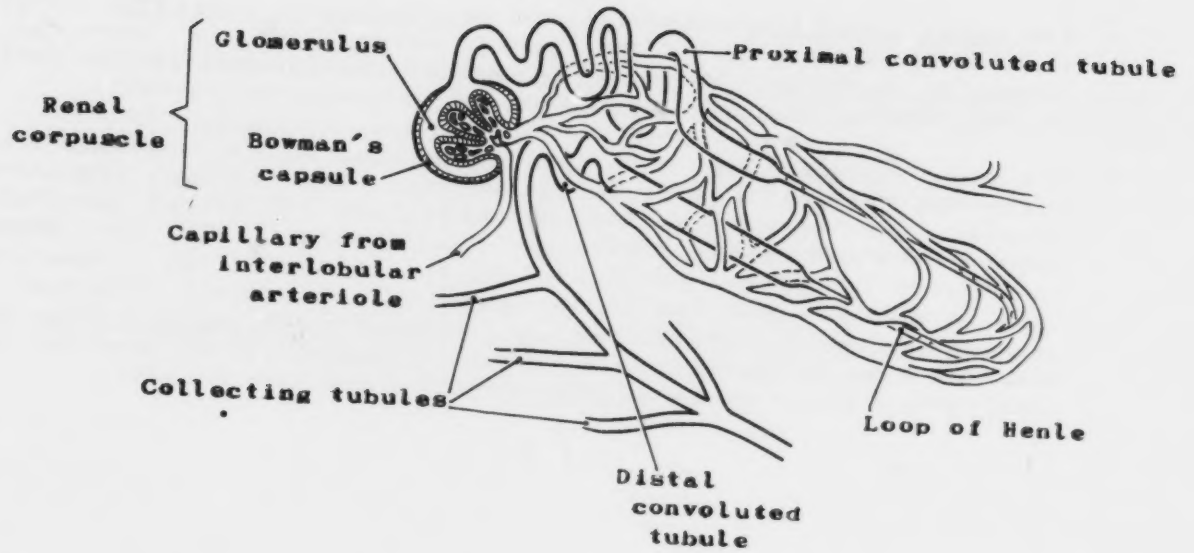
The Structural and Functional Unit of the Kidney

The structural and functional unit of the kidney is called a nephron. Each kidney has hundreds of thousands of these nephrons each of which is composed of a renal corpuscle and a renal tubule.

- The renal corpuscle consists of a glomerulus (a capillary cluster arising from a branch of the renal artery) and a surrounding Bowman's capsule. All of the glomeruli are located in the cortex of the kidney.
- The renal tubule begins in the glomerular capsule and has three different designations along its course: the proximal convoluted tubule, the descending loop of Henle, and the distal convoluted tubule (the end of the nephron). The proximal and the distal convoluted tubules are located in the cortex of the kidney; the loop of Henle is located in the medulla. The distal tubules of several nephrons empty into a common collecting tubule that transports urine back into the renal pyramids of the medulla and then into a minor calyx of the renal pelvis.

capillary--a minute blood vessel

Figure 3. A NEPHRON



The function of the kidney is to remove metabolic waste products from the blood and to maintain the electrolyte balance. This is accomplished by the production of urine.

The formation of urine and the regulation of the internal environment of the body by the kidneys are a composite of four processes:

- Filtration of the blood through the capillaries of the glomerulus into Bowman's capsule
- Selective reabsorption by the renal tubules of materials required to maintain the internal environment of the body, i.e., the fluid and electrolyte balance
- Secretion of certain substances produced in the distal and collecting tubules causing potassium, hydrogen ions, and other substances to be taken from the blood and added to the tubular filtrate.
- Maintenance of acid-base balance (pH 7.4) by regulating the amount of acid or base which the kidneys eliminate in the urine.

pH--refers to the hydrogen ion concentration expressing both acidity and alkalinity on a scale whose values run from 0 to 14 with 7 representing neutrality, numbers less than 7 increasing acidity, and numbers greater than 7 increasing alkalinity.

The Production of Urine

The aorta brings waste-filled blood from the heart to the kidneys way of the renal arteries. Here in the kidneys the waste products metabolism and toxic substances are eliminated. Blood enters the glomerulus through the afferent arteriole which divides into capillaries. These will later unite to form the efferent arteriole that drains blood from the glomerulus. As the blood passes through the glomerulus, water, glucose, salts, and nitrogenous wastes are filtered into Bowman's capsule which is the beginning of the renal tubule. The contents of the distal portion of the tubule pass to branches of the collecting tubule which empty into the calyces of the renal pelvis. These contents are then transported through the ureters from the renal pelvis to the bladder. Certain substances required to maintain fluid and electrolyte balance are reabsorbed by the peritubular capillaries (e.g., sodium, glucose, water) and returned to the blood. Secretions produced in the distal and collecting tubules cause other substances to be added to the tubular filtrate from the blood (e.g. potassium and hydrogen ions, ammonia).

Through the capillaries of the glomeruli, approximately 120 milliliters (ml) of water and salts are filtered from the blood each minute. Most of the water is reabsorbed as are other essential substances unless their concentration in the body happens to be too high. The urine passes out through the collecting tubules at a rate of approximately 1.5 milliliter per minute, so that a healthy person will excrete about 1 to 1 and 1/2 liters per day.

peritubular capillaries--capillary beds that surround the renal tubules

Q4

Why is blood circulated through the kidneys?

a. _____

b. _____

Q5

What is the structural and functional unit of the kidney?

Q6

Through which parts of the kidney are water and salts filtered?

Q7

Give the names of the major structures involved in the urinary process from the point at which blood enters the capillaries in the cortex of the kidney until it enters the calyces of the renal pelvis.

1. _____

2. _____

3. _____

4. _____

Answer: Q4

The blood is circulated through the kidneys:

- a. To excrete waste products of metabolism and toxic substances from the body.
- b. To help maintain the fluid and electrolyte balance.

Answer: Q5

The nephron is the structural and functional unit of the kidney.

Answer: Q6

Water and salts are filtered through the capillaries of the glomeruli.

Answer: Q7

The major structures involved in the urinary process from the point at which blood enters the capillaries in the cortex of the kidney until it enters the calyces of the renal pelvis are:

1. Glomerulus
2. Bowman's capsule
3. Renal tubule
4. Collecting tubule

Regional Lymph Nodes

The regional lymph node drainage for the kidneys is to the hilar (small nodes at the renal hilus), paracaval (lateral caval), and para-aortic (retroperitoneal) lymph nodes.

Malignant Tumors

Tumors which arise in the kidney parenchyma or the renal pelvis usually can be distinguished by the histologic type:

Malignant tumors of the kidney parenchyma:

- Adenocarcinoma makes up 80 percent of renal tumors. It may also be called hypernephroma, renal cell carcinoma, and Grawitz's tumor.
- Wilms' tumor or nephroblastoma is the most common abdominal malignancy in children. It is almost exclusively a disease of children under six years of age. It is a mixed tumor histologically made up of embryonal tissue, probably of nephrogenic origin. It is highly malignant but often is successfully treated.

Malignant tumors of the renal pelvis:

- Transitional cell carcinoma is the most common tumor of the renal pelvis.
- Squamous cell carcinoma is rare.

Tumors of the renal pelvis comprise 15-18 percent of the renal malignancies.

! indicates a change from the 1986 publication from "lateral caval" to "paracaval" for consistency with the American Joint Committee on Cancer's Manual for Staging of Cancer, Third Edition.

Q8

The regional lymph node drainage for the kidneys is to:

1. _____
2. _____
3. _____

Q9

Indicate whether the following tumors would most likely arise in the kidney parenchyma (use symbol k) or in the renal pelvis (use symbol p)

- _____ 1. Transitional cell carcinoma
- _____ 2. Wilms' tumor
- _____ 3. Adenocarcinoma
- _____ 4. Squamous cell carcinoma

Q10

What is the major kidney tumor occurring in childhood?

Q11

What is the most common type of kidney cancer?

Answer: Q8

The regional lymph node drainage for the kidneys is to:

1. Hilar lymph nodes
2. Paracaval lymph nodes
3. Para-aortic (retroperitoneal) lymph nodes

Answer: Q9

The following tumors would most likely arise in the kidney parenchyma (indicated by k) or the renal pelvis (indicated by r):

- | | |
|----------|--------------------------------|
| <u>r</u> | 1. Transitional cell carcinoma |
| <u>k</u> | 2. Wilms' tumor |
| <u>k</u> | 3. Adenocarcinoma |
| <u>r</u> | 4. Squamous cell carcinoma |

Answer: Q10

The major kidney tumor occurring in childhood is Wilms' tumor.

Answer: Q11

The most common type of kidney cancer is adenocarcinoma. It may also be called a renal cell carcinoma, hypernephroma, or Grawitz's tumor.

Ureters

Each kidney is connected to the urinary bladder by a ureter. These muscular tubes are about 26 to 28 cm in length, beginning at the renal pelvis. They transport urine from the kidney to the bladder.

The microscopic structure of the ureter is similar to that of the renal pelvis consisting of a mucosa of epithelium and lamina propria, a submucosa, a muscularis propria, and an outer adventitia of fibroelastic connective tissue.

Regional Lymph Nodes

The regional lymph node drainage for the ureters is to the peri-ureteral and iliac (common, internal (hypogastric), and external) lymph nodes.

Malignant Tumors

Primary cancer of the ureter is rare. When cancer does occur, it is usually transitional cell carcinoma, resembling cancer of the renal pelvis; it often presents as an ureteral obstruction.

Q12

What is the tube which carries urine from the kidney to the bladder? _____

Q13

What are the tissue layers of the renal pelvis excluding the basement membrane?

- | | | |
|----------|---|--------|
| 1. _____ | } | Mucosa |
| 2. _____ | } | |
| 3. _____ | | |
| 4. _____ | | |
| 5. _____ | | |

Answer: Q12

The tube which carries urine from the kidney to the bladder is the ureter.

Answer: Q13

The tissue layers of the renal pelvis are:

1. Epithelium }
2. Lamina propria }
3. Submucosa
4. Muscularis propria (or two layers of smooth muscle)
5. Adventitia

Urinary Bladder

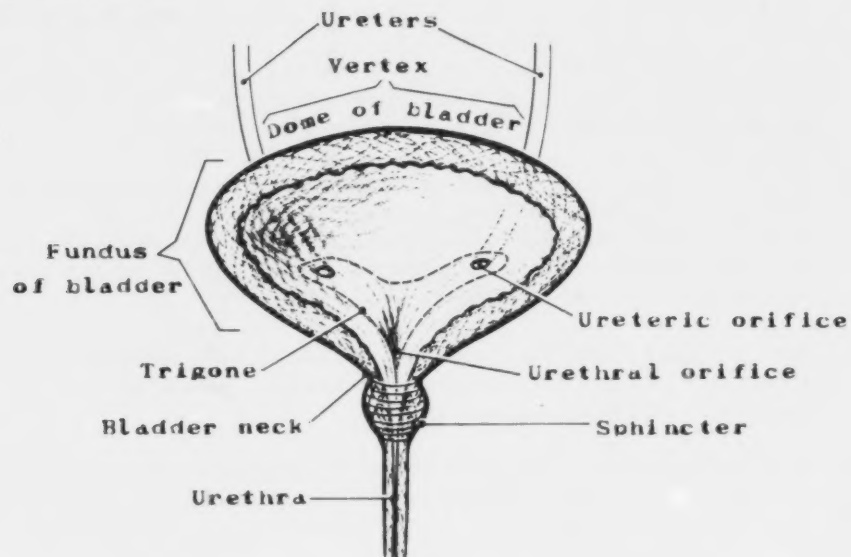
The urinary bladder is a hollow muscular organ which serves as a reservoir for urine. It lies in the pelvis behind the pubic bone. The adult urinary bladder has a capacity of 300-350 milliliters.

Three openings mark off a triangular area called the trigone at the base of the bladder. These are the orifices of the two ureters and the urethra. The trigone is smooth even when the bladder is empty; the remainder of the bladder wall is in folds allowing for expansion when the bladder is full. The superior surface of the bladder may be referred to as the dome; other subsites are the lateral, anterior, and posterior walls. The trigone may also be referred to as the floor or base.

In the female, the bladder is located in front of and below the uterus being separated from the anterior part of the uterus by a fold of peritoneum called the uterovesical pouch. Posteriorly, it is connected to the cervix and upper vagina by a thick layer of connective tissue.

In the male, the inferior surface of the bladder which is not covered by peritoneum is in proximity to the upper rectum and is separated from it by the rectovesical fascia which contains the seminal vesicles and vas deferens. The prostate lies just below the bladder and surrounds the proximal part of the urethra as it emerges from the urinary bladder.

Figure 4. URINARY BLADDER



URINARY BLADDER, RENAL PELVIS and URETERS

PRIMARY SITE	MUCOSA	LAMINA PROPRIA	SUBMUCOSA	MUSCULARIS PROPRIA	SEROSA
	Epithelium	[B] [A] [S] [E] [I] [M] [E] [B] [R] [A] [N] [E] [I]			
Urinary Bladder (188.-)	Yes		Yes	Yes	Yes, or dome
Renal pelvis (189.1)	Yes		Yes	Yes	No
Ureter (189.2)	Yes		Yes	Yes	No

The bladder wall has the same three tissue layers as the renal pelvis and ureter:

• MUCOSA

The EPITHELIAL LAYER contains no blood vessels or lymphatics.

The BASEMENT MEMBRANE is a sheet of extracellular material that functions as a filtration barrier and a boundary which helps to generate and maintain tissue structure.

- LAMINA PROPRIA, composed of areolar connective tissue, contains blood vessels, nerves, and, in some regions, glands. Once tumor has broken through the basement membrane into the lamina propria, it can spread by way of the lymphatics and blood vessels to the other parts of the body.

The urinary sites have NO MUSCULARIS MUCOSAE, and therefore, the lamina propria and the submucosa tend to merge; these terms will be used interchangeably.

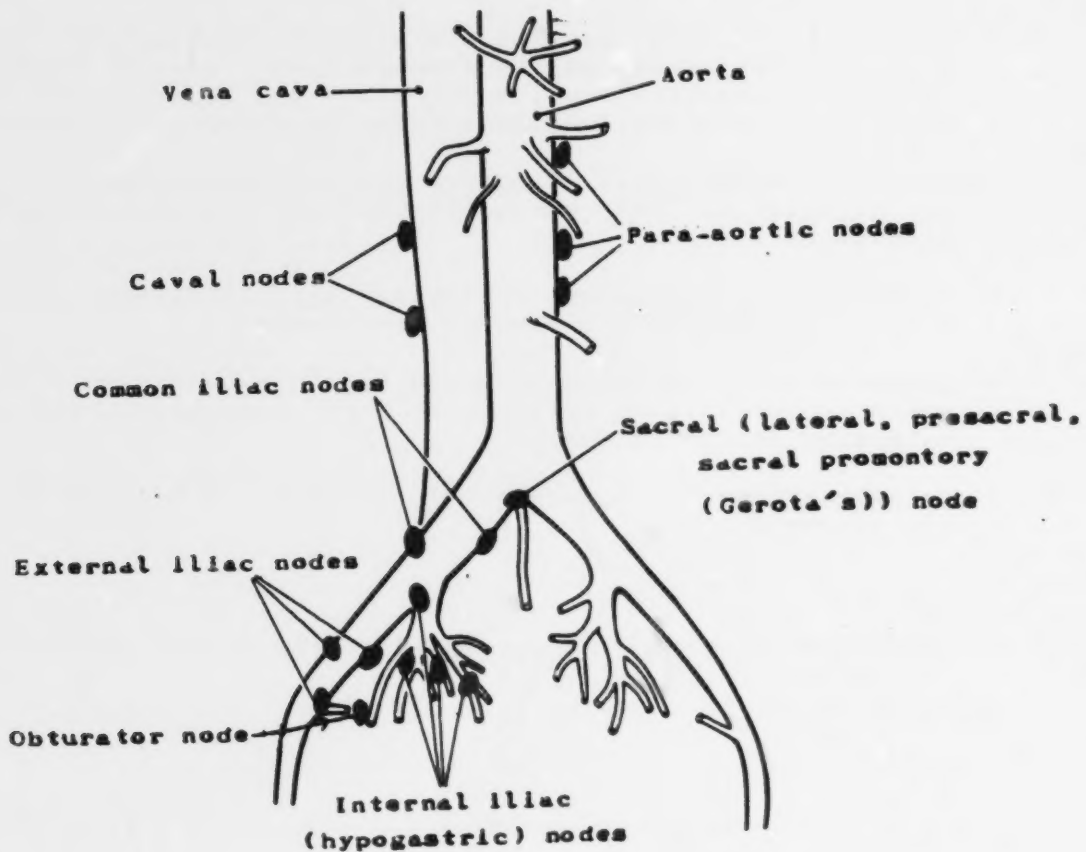
- The SUBMUCOSA is a thick layer of connective tissue. It contains blood vessels, lymphatic vessels, nerves, and, in some regions, glands.
- MUSCULARIS PROPRIA consists of three layers of smooth muscle which provide the ability to expand and contract.
- The superior and posterior aspects of the bladder have a peritoneal covering (peritoneum) which is not found inferiorly.

Regional Lymph Nodes

The regional lymph nodes draining the bladder are:

Internal iliac (hypogastric)
External iliac
Obturator
Sacral (lateral, presacral, promontory (Gerota's) or NOS)
Perivisceral

Figure 5. LYMPHATIC DRAINAGE OF THE BLADDER



Malignant Tumors

Bladder cancer is the most frequent malignancy of the urinary tract and it is more common in men than in women. Most bladder tumors are papillary in appearance and will often occur and recur in multiple sites within the bladder. The lateral and posterior walls are involved with tumor more frequently than is the trigone. There is a high frequency of bladder cancer in heavy smokers.

- Transitional cell carcinoma is the most common bladder cancer accounting for 90-95 percent of bladder tumors. The grading, as well as the staging, of these tumors is of particular significance in prognosis, there being a high level of correlation between grade (differentiation) and stage (invasiveness).

There are different grading systems. Using Broders' Classification, bladder tumors may be diagnosed as carcinoma Grades I - IV. In other classifications, Broders' Grade I tumor is called papilloma, with further subdivision into carcinoma Grades I - II.

Foci of squamous cell carcinoma and adenocarcinoma may be found in association with transitional cell carcinoma, especially in high-grade tumors.

- Squamous cell carcinoma occurring in a pure form is rare, less than 10 percent of all bladder carcinomas.
- Adenocarcinoma of the bladder is rarely found in pure form and is almost impossible to distinguish from prostatic carcinoma with extension to the bladder.
- Leiomyosarcoma is a rare tumor arising in the smooth muscle of the bladder.

Broders, Albert C.--a pathologist who formulated a four-grade classification of malignancy based on the degree of cellular dedifferentiation.

Q14

What is the term for the muscular sac which serves as a reservoir for urine? _____

Q15

What is the trigone area of the organ referred to in Q14 above?

Q16

Which of the following lymph nodes are regional for the bladder?

- ☐ a. Supraclavicular
- ☐ b. External iliac
- ☐ c. Inguinal
- ☐ d. Obturator
- ☐ e. Para-aortic (retroperitoneal)

Q17

What are the layers of the bladder wall (interior to exterior)?

1. _____ (a) _____ (b) _____
2. _____
3. _____
4. _____

Answer: Q14

The urinary bladder is a reservoir for urine.

Answer: Q15

You might have said: The trigone area of the bladder is triangular area at the base of the bladder marked off by the orifices of the two ureters and the urethra.

Answer: Q16

Regional nodes for the bladder are:

- b. External iliac
- d. Obturator

Answer: Q17

The layers of the bladder wall (interior to exterior) are:

1. Mucosa of (a) epithelium and (b) lamina propria
2. Submucosa
3. Muscularis propria or musculature (three layers of smooth muscle)
4. Serosa (superior surface only)

Urethra

The urethra is a membranous tube which conveys urine from the urinary bladder to the exterior of the body.

At the proximal end is a circular smooth muscle which surrounds the bladder neck and is known as the internal sphincter. It is controlled by the autonomic nervous system. The external sphincter of the urethra is a circular striated muscle which is under voluntary control. In the female the external sphincter is located in the vulva; in the male it is in the glans penis.

The urethra differs in men and women:

The female urethra is a part of only the excretory system and is approximately 2.5 - 3.0 cm long.

The male urethra is a part of both the excretory system and the reproductive system. It has three regions:

- The prostatic urethra which passes through the prostate gland is approximately 2.5 cm long.
- The membranous urethra which comprises the external muscular section is approximately 1.3 cm long.
- The penile (spongy or cavernous) urethra which passes through the penis is approximately 9.0 - 15.0 cm long.

Regional Lymph Nodes

The regional lymph nodes of the urethra are:

Common iliac
Internal iliac (hypogastric): Obturator
External iliac
Periurethral
Inguinal

Malignant tumors of the urethra are rare and are almost always transitional cell carcinomas.

| indicates a change from the 1986 publication adding "common iliac, obturator, periurethral, and inguinal" to regional nodes for consistency with the American Joint Committee on Cancer's Manual for Staging of Cancer, Third Edition.

Q18

The _____ is a membranous tube which conveys urine from the urinary bladder to the exterior of the body.

Q19

Match the terms on the left with the descriptions on the right.

- | | |
|---------------------------|---|
| _____ 1. Bowman's capsule | a. Tubules leading from Bowman's capsule to the collecting tubules |
| _____ 2. Renal tubules | b. Tube carrying urine from the bladder to the outside of the body |
| _____ 3. Glomerulus | c. Muscular sac which serves as a reservoir for urine |
| _____ 4. Urethra | d. Tubes carrying urine from the kidney to the urinary bladder |
| _____ 5. Ureters | e. Collection of capillaries through which blood is filtered |
| _____ 6. Bladder | f. Structure in the kidney which receives the filtered materials directly from the glomerulus |
| _____ 7. Nephron | g. The structural and functional unit of the kidney |

Q20

The renal pelvis is:

- ☐ a. a muscular sac which serves as a reservoir for urine.
- ☐ b. the central urine-collecting structure of the kidney from which urine is delivered to the bladder via the ureters.
- ☐ c. a structure which receives the filtered materials directly from the glomerulus.
- ☐ d. the outer layer of the kidney.

Answer: Q18

The urethra is a membranous tube which conveys urine from the urinary bladder to the exterior of the body.

Answer: Q19

- | | | |
|-------|---------------------|--|
| __f__ | 1. Bowman's capsule | Structure in the kidney which receives filtered materials directly from the glomerulus |
| __a__ | 2. Renal tubules | Tubules leading from Bowman's capsule to the collecting tubules |
| __e__ | 3. Glomerulus | Collection of capillaries through which blood is filtered |
| __b__ | 4. Urethra | Tube carrying urine from the bladder to the outside of the body |
| __d__ | 5. Ureters | Tubes carrying urine from the kidney to the urinary bladder |
| __c__ | 6. Bladder | Muscular sac which serves as a reservoir for urine |
| __g__ | 7. Nephron | The structural and functional unit of the kidney |

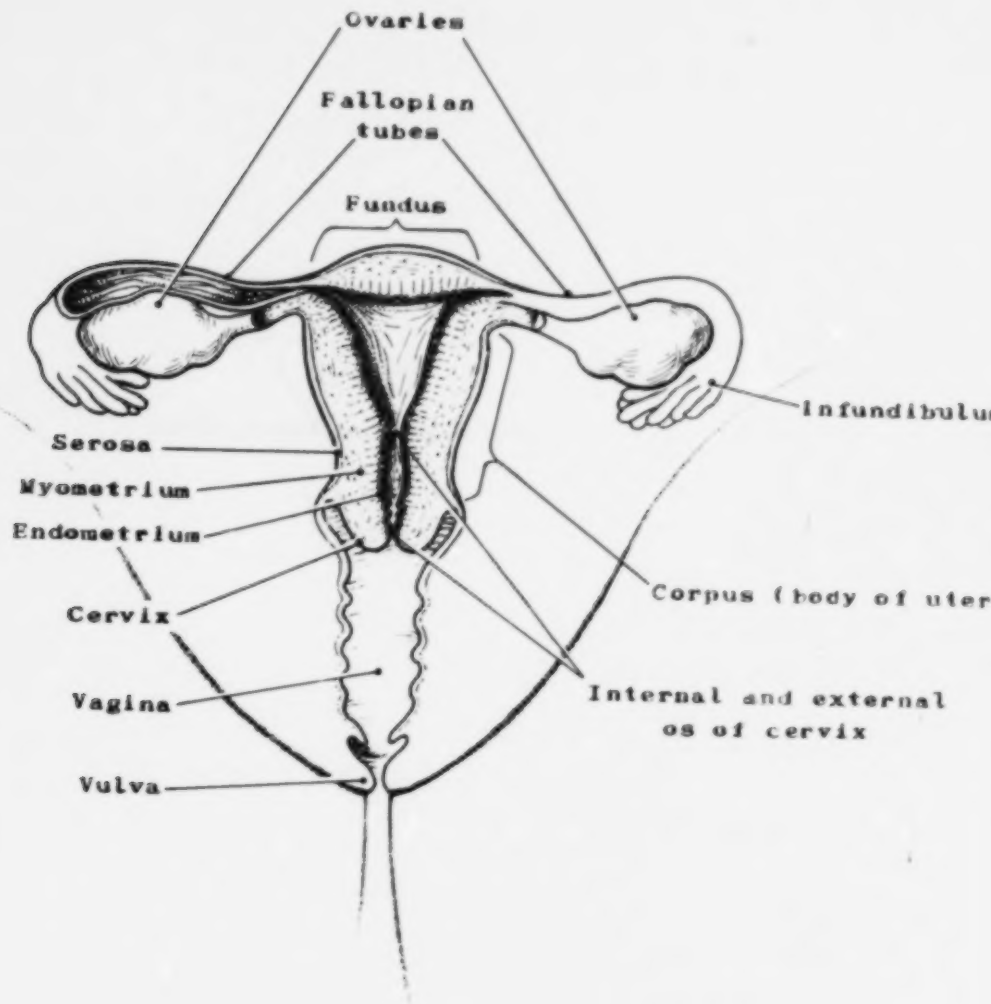
Answer: Q20

The renal pelvis is:

- b. the central urine-collecting structure of the kidney from which urine is delivered to the bladder via the ureters.

SECTION I
THE REPRODUCTIVE SYSTEM

Figure 6. FEMALE PELVIS (frontal view)



SECTION I

THE REPRODUCTIVE SYSTEM

Female Reproductive System

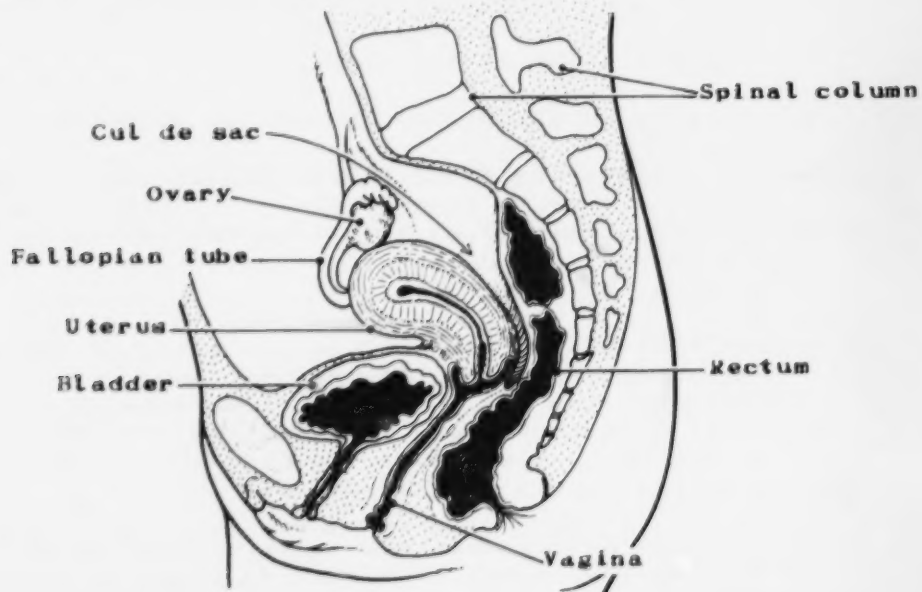
The female reproductive system is made up of the uterus and two ovaries, two fallopian tubes (uterine tubes or oviducts), a vagina, and a vulva (pudendum or external genitalia). Two breasts (or mammary glands) are considered to be accessory organs of the female reproductive system and will be discussed in this section.

Uterus

The uterus is a hollow, pear-shaped, muscular organ located in the pelvic cavity between the bladder and the rectum. The uterus plays a role in three important functions: menstruation, pregnancy, and parturition. It is composed of two parts, an upper portion called the corpus (or body), and a lower, narrow part called the cervix. The fundus is that portion of the corpus which rounds into a bulging prominence at about the level at which the fallopian tubes enter the corpus.

Midway between the uterus and the rectum is a region in the abdominal cavity known as the cul de sac. It is important that you remember this term because it will be examined for the presence of cancer.

Figure 7. FEMALE PELVIS (sagittal view)



CORPUS UTERI

PRIMARY SITE	ENDOMETRIUM (mucosa)	MYOMETRIUM (3 muscle layers)	PERIMETRIUM (serosa)
	Columnar Epithelium	Stroma (Lamina Propria)	
Corpus Uteri (182.-)	Yes	Yes	Yes
	MEMBRANE		

The wall of the uterine corpus is composed of the following microscopic layers:

● ENDOMETRIUM

The EPITHELIAL LAYER contains no blood vessels or lymphatics.

The BASEMENT MEMBRANE is a sheet of extracellular material that functions as a filtration barrier and boundary which helps to generate and maintain tissue structure.

The LAMINA PROPRIA, composed of areolar connective tissue, contains blood vessels, nerves, and, in some regions, glands. Once tumor has broken through the basement membrane into the lamina propria, it can spread by way of the lymphatics and blood vessels to other parts of the body.

- There is NO MUSCULARIS MUCOSAE or SUBMUCOSA in the endometrium.
- The MYOMETRIUM, the thick middle layer, is composed of three layers of smooth muscle fibers: longitudinal, transverse, and oblique, that extend in all directions and give great strength to the uterus. It contains an abundance of blood vessels, lymphatics, and nerves.
- The PERIMETRIUM (serosa) is the external peritoneal covering. It is incomplete since it covers none of the cervix and only three-fourths of the anterior surface of the body of the uterus. It is continuous with the peritoneum of the broad ligament.

The uterine cervix is composed of:

- A MUCOSA of columnar glandular epithelium in the upper portion of the cervical canal (endocervix) which is continuous with that of the corpus. It becomes stratified squamous epithelium at the lower end of the canal extending onto the lip of the cervix (ectocervix or exocervix).
- A LAMINA PROPRIA (stroma) of dense connective tissue which contains a few smooth muscle fibers and the cervical glands.

Q1

The female reproductive organs are:

1. _____
2. _____
3. _____
4. _____
5. _____

Q2

The uterus is located in the _____ cavity between the _____ and the _____.

Q3

The uterus is composed of two parts, an upper portion called the _____, and a lower, narrow portion called the _____.

Q4

The portion of the body of the uterus which rounds into a bulging prominence at about the level at which the fallopian tubes enter is called the _____.

Q5

The three tissue layers of the body of the uterus are:

1. _____
2. _____
3. _____

Answer: Q1

The female reproductive organs are:

1. The uterus
2. Two ovaries
3. Two fallopian tubes (uterine tubes or oviducts)
4. A vagina
5. A vulva

Answer: Q2

The uterus is located in the pelvic cavity between the bladder and the rectum.

Answer: Q3

The uterus is composed of two parts, an upper portion called the body or corpus, and a lower, narrow portion called the cervix.

Answer: Q4

The portion of the body of the uterus which rounds into a bulging prominence at about the level at which the fallopian tubes enter is called the fundus.

Answer: Q5

The three tissue layers of the body of the uterus are:

1. Endometrium (mucosa)
2. Myometrium
3. Perimetrium (serosa)

The uterus has thick walls and a small, flat, triangular-shaped cavity. Its apex is directed downward and forms the internal os which opens into the cervical canal. The cervical canal narrows at its lower end and forms the external os opening into the vagina. The mucosa of the vaginal wall is contiguous with the mucosa of the cervix. A circular recess around the cervix at its junction with the vagina is called the fornix. It is divided into four fornices or parts: anterior, posterior, and two lateral. The fallopian tubes join the uterine cavity at the upper, outer angles. A generous blood supply is received by the uterus from the uterine arteries which are branches of the internal iliac arteries. Eight ligaments which hold the uterus in place but allow considerable movement are two broad ligaments, two uterosacral ligaments, the posterior ligament, the anterior ligament, and two round ligaments.

Parametrium, connective tissue which surrounds the uterus, separates the cervix from the bladder and extends between the two serosal layers of the broad ligaments as well as to and over the pelvic walls.

Regional Lymph Nodes

The regional lymph nodes for both the corpus and the cervix uteri are:

- Common iliac
- Internal iliac (hypogastric)
- External iliac
- Obturator (mainly cervix)
- Sacral (lateral, presacral, promontory (Gerota's) or NOS)
- Parametrial
- Paracervical

Para-aortic (The para-aortic (retroperitoneal) lymph nodes are second station nodes for the cervix.)

Malignant Tumors

The histologic types of cancer arising in the uterus are:

- Adenocarcinoma arising in the glandular epithelium of the endometrium and of the upper two-thirds of the cervical canal
- Leiomyosarcoma arising in the smooth muscle of the myometrium
- Adenosquamous carcinoma arising at the squamous columnar junction
- Squamous cell carcinoma arising in the lower one-third of the cervical canal and the lip of the cervix, and often extending into the vagina. The majority of the neoplasms arising in the cervix will arise in the lower one-third. These will be chiefly in situ, i.e., there will be no stromal invasion. Lesions with stromal invasion of 3 mm or less may be described as microinvasive.
- Endometrial stromal sarcoma
- Choriocarcinoma, a highly malignant tumor composed of chorionic (placental) type tissue
- Mullerian mixed tumor (mixed mesenchymal or mesodermal sarcoma), a relatively large group of sarcomas with no single histologic pattern
- Carcinosarcoma, a tumor of the endometrium which is composed of carcinomatous elements as well as stroma with characteristics of sarcoma.

Q6

For each of the sites below, list four lymph node groups that drain these sites.

Corpus:

Cervix:

Answer: Q6

For corpus uteri you might have said:

- Common iliac
- Internal iliac (hypogastric)
- External iliac
- Paracervical
- Parametrial
- Obturator
- Sacral

For cervix uteri you might have said:

- Common iliac
- Internal iliac (hypogastric)
- External iliac
- Sacral
- Obturator
- Paracervical
- Parametrial

Ovaries

The ovaries, female gonads, are the shape and size of large almonds and are located one on either side of the uterus, below and behind the fallopian tubes. Each ovary lies between the folds of the broad ligament and is attached to its posterior surface by the mesovarian ligament. The ovarian ligament anchors it to the uterus. The distal portion of the fallopian tube curves about the ovary so that a fimbriated cup hangs over each ovary but is not actually attached to it. The ovary is an example of a gland whose duct is detached from it.

Microscopically, the ovary consists of a layer of germinal epithelial cells and a layer of connective tissue in which structures known as graafian follicles are embedded. When a graafian follicle matures (usually one per month alternating between right and left ovaries), it expels an ovum. This process is called ovulation. After ovulation, the wall of the follicle is transformed into an endocrine gland, the corpus luteum, which secretes progesterone and some estradiol. The corpus luteum lasts only about 12-14 days if the ovum is not fertilized; it then deteriorates into a small fibrous cicatrix. When the ovum has been fertilized, it travels to the uterus and becomes embedded in endometrial tissue. The developing trophoblast produces hormones (chorionic gonadotrophins) which stimulate the corpus luteum to increase in size and to prolong its production of progesterone which furthers the developing of the endometrium and the anchoring and nurturing of the embryo. Near the end of pregnancy the corpus luteum shrinks and over a period of months undergoes the same degenerative changes as when the ovum is not fertilized.

The development and activities of the graafian follicle and of the corpus luteum are triggered by hormones secreted by the pituitary gland. However, as indicated above, the ovary itself has a hormonal function. During the maturation of the graafian follicle, certain cells (thecal and granulosa) surrounding or sheathing the developing ovum produce estrogenic hormones, mainly estradiol and estrone. These cells are replaced by the luteal cells after ovulation. The normal cyclical process of menstruation, with development and degeneration of endometrial cells, is governed by these hormonal activities of the pituitary and the ovaries.

Regional Lymph Nodes

Regional lymph node metastasis from the ovary is infrequent, but when it occurs it is primarily to the para-aortic nodes. However, any of the following may be considered regional lymph nodes draining the ovaries:

Common iliac	Obturator
Internal iliac (hypogastric)	Lateral sacral
External iliac	Inguinal (rare)
Para-aortic (retroperitoneal)	

gonads--organs which produce sex cells--ovaries and testes

cicatrix--scar resulting from formation and contraction of fibrous tissue

trophoblast--the ectodermal layer covering and attaching the embryo to the uterine wall and supplying nutrition for it

Fallopian tubes

The fallopian tubes, also called oviducts and uterine tubes, are attached to the uterus at its upper, outer angles. They lie between the folds of the broad ligaments and extend upward and outward towards the pelvic sidewalls and then curve downward and backward.

The walls of the tubes are composed of the same three tissue layers as the uterine corpus:

- A ciliated mucous lining of epithelial tissue. (The cilia propel the ovum from the ovary to the uterus.)
- Smooth muscle
- Serosa (or external peritoneal covering)

At the distal end, each tube expands into a funnel-like portion (the infundibulum) which resembles a fringe or is "fimbriated." Here the mucous lining of the tubes is directly continuous with the peritoneum. The fallopian tubes serve as ducts for the ova produced by the ovaries. Fertilization (union of a spermatozoon and an ovum) normally occurs in the fallopian tubes. Tumors of the fallopian tubes are extremely rare.

Regional Lymph Nodes

The regional lymph nodes for the fallopian tubes are:

Common iliac	Obturator
Internal iliac (hypogastric)	Inguinal
External iliac	
Para-aortic (retroperitoneal)	
Lateral sacral	

| indicates a change from the 1986 publication adding "lateral sacral" nodes to regional nodes for consistency with the ovary scheme.

Figure 8. LYMPHATICS OF THE UTERUS AND OVARIES

07

Match the sites on the left with the descriptions on the right.

- | | |
|--------------------------|--|
| ----- 1. Uterus | a. Ducts through which ova travel into the uterus |
| ----- 2. Fallopian tubes | b. Pear-shaped muscular organ in the pelvic cavity in which the embryo develops after fertilization |
| ----- 3. Ovaries | c. Organs which produce ova and hormones associated with female reproduction and secondary sex characteristics |

Answer: Q7

 b 1. Uterus

Pear-shaped muscular organ in the pelvic cavity in which the embryo develops after fertilization

 a 2. Fallopian tubes

Ducts through which ova travel into the uterus

 c 3. Ovaries

Organs which produce ova and hormones associated with female reproduction and secondary sex characteristics

Malignant Tumors

Common histologic types of ovarian tumors are as follow:

- Cystadenocarcinoma is a malignant tumor growing within a cyst, the walls of which are lined with columnar epithelial cells. This glandular epithelium may be serous-secreting or mucinous-secreting giving rise to:
 1. Serous cystadenocarcinoma, a cystic cavity which is lined with ciliated epithelial cells and contains serous fluid. It is the most common malignant tumor of the ovary.
 2. Mucinous cystadenocarcinoma, a cystic cavity which is lined with ciliated epithelial cells and contains mucin. These mucinous cystadenocarcinomas sometimes rupture and spill their contents into the peritoneal cavity. This spillage causes a clinical condition called pseudomyxoma peritonei in which tumor is implanted on all serosal surfaces and the abdominal contents are matted together.
- Endometrioid carcinoma is an ovarian tumor of epithelial origin that microscopically resembles a tumor originating in the endometrium.
- Dysgerminoma is a relatively uncommon tumor of germ cell origin, the counterpart of seminoma of the testis.
- Teratocarcinoma or malignant teratoma is a tumor of germ cell origin composed of embryonic tissue which is differentiated into bone, hair, teeth, cartilage, and skin. All these types of tissues may be found in the tumor. A benign tumor with these characteristics is called a dermoid.
- Granulosa cell and theca cell tumors arise from cells of the early ovarian mesenchyme in the ovarian stroma which surrounds the developing ovum. They are sometimes called feminizing or estrogen-producing tumors.
- Krukenberg tumor is a metastatic tumor of the ovary, usually from a primary in the stomach or other gastrointestinal site, with a marked ovarian tissue proliferation.

Less common tumors of the ovary are: Brenner tumors, arrhenoblastoma (masculinizing tumor), fibrosarcoma, and mesonephric tumors.

Ovarian tumors are frequently bilateral. They spread by implantation to the peritoneum, omentum, and serosal surfaces. They may also arise as independent primaries with no evidence of intraperitoneal spread.

Q8

Name the three openings of the uterus:

Q9

The walls of the fallopian tubes are composed of the same three tissue layers as the uterus except that the mucosa is _____ to propel the ovum.

Q10

What is the purpose of the fallopian tubes? _____

Q11

The regional lymph nodes which drain the fallopian tubes and the ovaries are:

12

In relation to the uterus, the ovaries are located _____.

13

The fimbriae of the fallopian tubes cup over the ovaries but are not actually attached to them. This is an example of a gland whose _____ is detached.

Answer: Q8

In naming the three openings of the uterus you might have said the openings of two fallopian tubes (oviducts or uterine tubes) and the opening into the vagina (or the external os).

Answer: Q9

The walls of the fallopian tubes are composed of the same three tissue layers as the uterus except that the mucosa is ciliated to propel the ovum.

Answer: Q10

You might have said the fallopian tubes serve as ducts to carry the ova produced by the ovaries to the uterus.

Answer: Q11

The regional lymph nodes draining the fallopian tubes and the ovaries are:

- Common iliac
- Internal iliac (hypogastric)
- External iliac
- Obturator
- Lateral sacral
- Para-aortic (retroperitoneal)
- Inguinal

Answer: Q12

The ovaries are located on either side of the uterus below and behind the fallopian tubes.

Answer: Q13

The fimbriae of the fallopian tubes cup over the ovaries but are not actually attached to them. This is an example of a gland whose duct is detached.

Vagina

The vagina is situated posterior to the bladder and anterior to the rectum. It extends upward and backward from the vaginal orifice to the uterus. The vagina is a collapsible tube, capable of great distension, composed mostly of smooth muscle lined with a mucous membrane of stratified squamous epithelium and connective tissue (stroma) arranged in rugae. It is about 3 inches (7.5 cm) in length. A fold of mucous membrane, the hymen, forms a border around its external opening in the virginal state. The functions of the vagina include: 1) receiving semen from the male; 2) serving as the lower part of the birth canal; and 3) acting as the excretory duct for uterine secretions and the menstrual flow.

The region between the vaginal orifice and the anus is called the perineum.

Vulva

The external female genitalia (or vulva) consist of the following structures:

- The mons pubis (mons veneris) is a skin-covered pad of fat over the symphysis pubis (pubic bone).
- Labia majora (large lips) are covered with pigmented skin and hair on the outer surface, smooth and free from hair on the inner surface, and composed mainly of fat and glands.
- Labia minora (small lips) are located within the labia majora and are covered with a modified skin. (These labia come together anteriorly in the midline, and the area between them is called the vestibule of the vagina.)
- The clitoris, a small organ composed of erectile tissue located just behind the upper junction of the labia minora, corresponds in structure to the corpora cavernosa and glans of the penis in the male. The prepuce or foreskin covers the clitoris as it does the glans penis in the male.
- The urinary (urethral) meatus, the small opening of the urethra located between the clitoris and the vaginal orifice.
- The vaginal orifice, the opening into the vagina, located posterior to the urinary meatus.
- Bartholin's glands (greater vestibular glands), two bean-shaped glands, one on either side of the vaginal orifice. Each gland opens by means of a single, long duct into the space between the hymen and the labia minora and corresponds to the bulbourethral glands in the male. They secrete a lubricating fluid.
- Skene's glands (lesser vestibular glands) open into the vestibule of the vagina near the urinary meatus through two small ducts. They are a group of tiny mucous glands.

Rugae--ridges, wrinkles, or folds of mucous membrane

Regional Lymph Nodes

The regional lymph nodes draining the vagina for the:

Upper two-thirds of vagina only are:

Pelvic nodes:
Common iliac
External iliac
Internal iliac (hypogastric)
Sacral

Lower one-third of vagina only are:

Superficial inguinal (femoral)
Deep inguinal: Rosenmuller's or Cloquet's node

The regional lymph nodes draining the vulva are:

Superficial inguinal (femoral)
Deep inguinal: Rosenmuller's or Cloquet's node
External iliac
Internal iliac (hypogastric)

Malignant Tumors

The most common histologic type of malignant neoplasm found in the vulva and vagina is squamous cell carcinoma. The usual spread of disease from the vagina is to the cervix, vulva, rectum, and bladder. For tumors arising in the vulva, the usual spread of disease is to the vagina, urethral orifice, and perineum.

| indicates a change from the 1986 publication specifying that the "iliac" and "sacral" nodes are regional for the upper 2/3 of the vagina only and adding "inguinal" nodes as regional for the lower 1/3 of the vagina for consistency with the American Joint Committee on Cancer's Manual for Staging of Cancer, Third Edition.

Q14

The vagina is situated between the _____, which is posterior to it, and the _____, which is anterior to it.

Q15

The vagina is a collapsible tube, the walls of which are composed of _____ lined with _____.

Q16

The female external genitalia are called the _____. Match each of its parts (on the left) with the descriptions on the right.

- | | |
|------------------------------------|--|
| _____ 1. Mons pubis (mons veneris) | a. A small organ composed of erectile tissue |
| _____ 2. Labia majora | b. The external opening of the vagina |
| _____ 3. Labia minora | c. A skin-covered pad of fat over the pubic bone |
| _____ 4. Clitoris | d. Tiny mucous glands opening into the vestibule near the urinary meatus |
| _____ 5. Urinary meatus | e. Covered with pigmented skin on outer surface and composed mainly of fat and glands |
| _____ 6. Vaginal orifice | f. Glands that secrete a lubricating fluid into the space between the hymen and the labia minora |
| _____ 7. Bartholin's glands | g. The small opening of the urethra located between the clitoris and the vaginal orifice |
| _____ 8. Skene's glands | h. Located within the labia majora and covered with modified skin |

Q17

Match the neoplasms on the left with the descriptions on the right:

- | | |
|---------------------------------|---|
| _____ 1. Cystadenocarcinoma | a. A metastatic ovarian tumor, usually a primary of the gastrointestinal tract, especially of the stomach |
| _____ 2. Dysgerminoma | |
| _____ 3. Krukenberg tumor | b. Malignant tumor derived from more than one type of germ cell and containing several tissue types |
| _____ 4. Teratocarcinoma | |
| _____ 5. Endometrioid carcinoma | c. An epithelial tumor that microscopically resembles a tumor of endometrial origin |
| | d. A tumor derived from the germ cells of the ovary comparable to seminoma of the testis in the male |
| | e. An adenocarcinoma growing within a cyst, serous or mucinous |

Q18

The most common histologic type of malignant tumor found in the vulva and vagina is _____.

For both sites, lymph node drainage is to the _____ and _____ nodes.

Answer: Q14

The vagina is situated between the rectum, which is posterior to it, and the bladder, which is anterior to it.

Answer: Q15

The vagina is a collapsible tube the walls of which are composed of smooth muscle lined with mucous membrane.

Answer: Q16

The female external genitalia are called the vulva. Each of its parts is described as follows:

- | | |
|------------------------------------|---|
| __c__ 1. Mons pubis (mons veneris) | A skin-covered pad of fat over the pubic bone |
| __e__ 2. Labia majora | Covered with pigmented skin on the outer surface and composed mainly of fat and glands |
| __h__ 3. Labia minora | Located within the labia majora and covered with modified skin |
| __a__ 4. Clitoris | A small organ composed of erectile tissue |
| __u__ 5. Urinary meatus | The small opening of the urethra located between the clitoris and the vaginal orifice |
| __b__ 6. Vaginal orifice | The external opening of the vagina |
| __f__ 7. Bartholin's glands | Glands that secrete a lubricating fluid into the space between the hymen and the labia minora |
| __d__ 8. Skene's glands | Tiny mucous glands opening into the vestibule near the urinary meatus |

Answer: Q17

- | | | |
|-------|---------------------------|---|
| __e__ | 1. Cystadenocarcinoma | An adenocarcinoma growing within a cyst, serous or mucinous |
| __d__ | 2. Dysgerminoma | A tumor derived from the germ cells of the ovary comparable to seminoma of the testis in the male |
| __a__ | 3. Krukenberg tumor | A metastatic ovarian tumor, usually a primary of the gastrointestinal tract, especially the stomach |
| __b__ | 4. Teratocarcinoma | Malignant tumor derived from more than one type of germ cell and containing several tissue types |
| __c__ | 5. Endometrioid carcinoma | An epithelial tumor that microscopically resembles a tumor of endometrial origin |

Answer: Q18

The most common histologic type of malignant tumor found in the vulva and vagina is squamous cell carcinoma.

For both sites, lymph node drainage is to the external and internal iliac nodes.

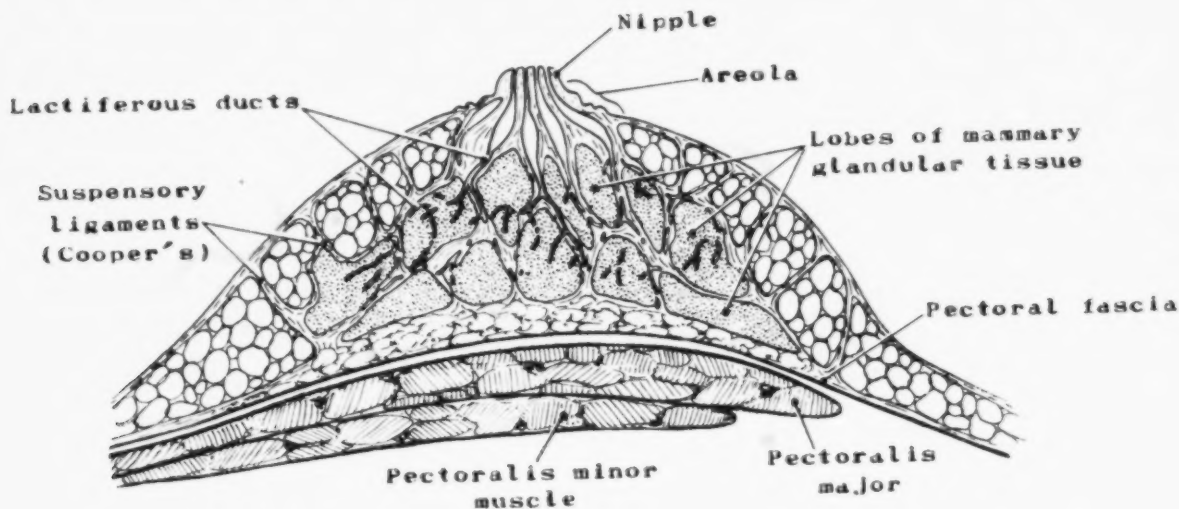
Breast

The breasts, or mammary glands, are modified sweat glands and, in some of the earlier classification systems, were grouped with the integumentary system. The breasts lie on top of the chest wall immediately over the pectoral muscles, pectoralis major and pectoralis minor, and are attached to the pectoralis major by a layer of connective tissue, the pectoral fascia. On the lower lateral aspect of the chest wall, the breasts are in contact with the serratus anterior muscles.

Each breast consists of many separate glands that are connected by individual ducts (lactiferous ducts) to the nipple. These glands constitute the lobes of the breast, 15 to 20 lobes (glands) for each breast. Each lobe is composed of many lobules which are formed from minute ducts and contain secreting cells (alveoli). The lobes are separated from each other by dense connective tissue and are surrounded by quantities of adipose tissue (fat). Suspensory ligaments (Cooper's ligaments) run from the corium of the skin through the breast to the fascia overlying the chest wall.

Located in the center of each breast is a nipple bordered by a circular pigmented area of skin called the areola. The lactiferous ducts from the lobes of the breast converge in the nipple. During pregnancy hormonal changes in the body stimulate the production of milk in the lobes (mammary glands); the ducts transport the milk to the nipple.

Figure 9. BREAST (sagittal view)



pectoral muscles--the function of the pectoralis major muscle is to adduct, flex, and rotate the humerus inward. The pectoralis minor lies beneath the pectoralis major and serves to depress the tip of the shoulder and to help rotate the scapula downward and forward.

serratus anterior muscles--this muscle draws the scapula forward and rotates it to raise the tip of the shoulder.

Q19

The breasts overlie the _____ muscles.

Q20

Each breast consists of multiple glandular _____
which are further subdivided into _____ formed from
minute ducts surrounded by alveoli.

Q21

The circular area bordering each nipple is called the _____.

Answer: Q19

The breasts overlie the pectoral muscles.

Answer: Q20

Each breast consists of multiple glandular lobes which are further subdivided into lobules formed from minute ducts surrounded by alveoli.

Answer: Q21

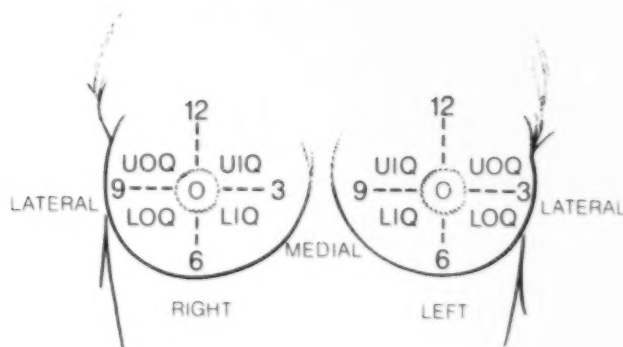
The circular area bordering each nipple is called the areola.

The female breast is classified according to the following subsites in ICD-O:

• Nipple/areola	174.0
• Central portion (subareolar, retroareolar)	174.1
• Upper-inner quadrant (UIQ)	174.2
• Lower-inner quadrant (LIQ)	174.3
• Upper-outer quadrant (UOQ)	174.4
• Lower-outer quadrant (LOQ)	174.5
• Axillary tail	174.6
• Inner/outer/lower/upper and midline	174.8

You will sometimes find the location described in terms of hours on the clock; it is important to note that this designation will be different for the inner and outer quadrants of the right and left breasts.

Figure 10. QUADRANTS OF THE BREAST



One shortcoming of our present classification system is that midline tumors, tumors at 3, 6, 9, and 12 o'clock, are grouped in a single category (174.8) in ICD-O, and thus lose their identification. Since a substantial number of tumors arise in these locations, we may be obscuring useful information by including all of them in code 174.8. Medial lesions, for instance, have a poorer prognosis because of their potential for metastasis to the internal mammary nodes.

A tumor specified as "subareolar" is coded to (174.1) the central portion of the breast indicating that the tumor is located directly under the nipple.

Extending outward from the nipple and areola and covering the entire surface of the breast is a layer of skin. Skin changes are significant in the clinical evaluation of breast cancer and indicate involvement of parenchymal tissue as well as invasion of the skin itself. Changes such as dimpling, tethering, and nipple retraction are presumed to be due to tension on Cooper's ligaments and not to actual skin involvement; adherence, attachment, fixation, induration, and thickening are usually due to extension of tumor to the skin or subcutaneous tissue. Edema, peau d'orange, en cuirasse, and ulceration clinically indicate extensive skin involvement.

peau d'orange--a dimpled skin condition resembling the skin of an orange
en cuirasse--an inflammatory process in which skin involvement resembles armor plate

The blood supply to the breast is from both the internal thoracic (subclavian) and the lateral thoracic (axillary) arteries. The veins form both superficial and deep plexuses and correspond in general to the arterial pattern.

Regional Lymph Nodes

The lymphatic vessels of the breast may be divided into the following categories:

Axillary lymph nodes (ipsilateral)

Low axillary (Level I): area next to the tail of the breast (lateral to the lateral border of the pectoralis minor muscle)

Mid axillary (Level II): area under the pectoralis minor muscles, including interpectoral (Rotter's) node

High axillary (Level III): apex of the axilla including subclavicular and apical nodes

Intramammary (coded as axillary lymph nodes)

Internal mammary (parasternal) lymph nodes (ipsilateral): in the intercostal spaces along the edge of sternum in the endothoracic fascia

Nodules of cancer cells found in the axillary fat which are not specifically identified as lymph nodes are considered to be nodes which have lost their architectural configuration or to be intransit metastases in the lymphatics.

Contralateral involvement of any of the above lymph nodes is considered distant lymph node metastasis.

All other lymph node metastases are coded as distant metastases, including any supraclavicular, infraclavicular, and cervical lymph nodes.

See illustration on page 34 of Book 4, Part I.

1 indicates a change from the 1986 publication deleting "infraclavicular" nodes from regional and putting them in distant for consistency with the American Joint Committee on Cancer's Manual for Staging of Cancer, Third Edition.

Q22

One of the first and most frequent areas of nodal metastasis in breast cancer patients is the _____ lymph nodes.

Q23

Match the axillary lymph node levels on the left with the descriptions on the right.

- _____ 1. Low
- _____ 2. Mid
- _____ 3. High

- a. Area next to the tail of the breast
- b. Apex of the axilla
- c. Area under the pectoralis minor muscles

Q24

What are the most frequently involved distant lymph nodes for breast cancer? _____

Answer: Q22

One of the first and most frequent areas of metastasis for breast cancer patients is the axillary lymph nodes.

Answer: Q23

- | | | |
|-------|---------|---|
| --a-- | 1. Low | Area next to the tail of the breast |
| --c-- | 2. Mid | Area under the pectoralis minor muscles |
| --b-- | 3. High | Apex of the axilla |

Answer: Q24

The most frequently involved distant lymph nodes for breast cancer are the supraclavicular (transverse cervical) lymph nodes.

Malignant Tumors

Ninety percent of all breast cancers arise from the glandular epithelial lining of the ducts. Thus, most tumors are intraductal in origin. The epithelium is supported by a basement membrane and an incomplete layer of myoepithelial cells. Invasion takes place when the tumor penetrates the basement membrane of the duct and grows into the supporting stroma. The histologic types of tumors generally described are:

- Intraductal (adeno)carcinoma, is a noninfiltrating or in situ lesion.
- Ductal (duct cell) (adeno)carcinoma is a general term denoting an infiltrating tumor of ductal origin.
- Medullary (adeno)carcinoma is a well-differentiated tumor of epithelial origin which will often have evidence of lymphoid infiltration in the stroma.
- Mucinous (adeno)carcinoma is a mucin-producing tumor which may have a gelatinous or colloid (glue-like) appearance when sufficient amounts of mucin are present.
- Lobular (adeno)carcinoma arises in the lobules of the breast as the name implies. It is most often diagnosed in situ but will eventually invade the parenchyma. Multiple foci are frequently found including foci in both breasts.
- Inflammatory carcinoma is a clinical term used to describe a condition in which there is diffuse involvement of the breast, particularly of the skin, causing widespread erythema, edema, and discoloration. It is generally inoperable and has a poor prognosis.
- Scirrhous (adeno)carcinoma is a tumor of ductal epithelial origin in which fibrous connective tissue has formed giving it a hard consistency.
- Paget's disease presents as a weeping eczematoid lesion of the nipple and areola. It occurs as a result of nipple invasion from an underlying ductal carcinoma. The presence of Paget's disease does not alter the staging of the original tumor.
- Cystosarcoma phyllodes, also known as cellular intracanalicular fibroma, is usually a benign disease contrary to the inclusion of "sarcoma" in the name of this tumor. It is one of the rare stromal tumors of the breast and, although it may become very large, cystic, and hemorrhagic, it only infrequently becomes invasive.

REVIEW TEST

Match the descriptions on the left with the organs on the right:

- | | |
|--|---------------------|
| _____ 1. Gonads in the female | a. Perineum |
| _____ 2. Muscular layer of the uterus | b. Cul de sac |
| _____ 3. Fringe bordering opening of the fallopian tube | c. Myometrium |
| _____ 4. Area between the vagina and anus | d. Ovaries |
| _____ 5. External genitalia of female | e. Fallopian tubes |
| _____ 6. Ducts through which the ova travel into the uterus | f. Female genitalia |
| _____ 7. Region of abdominal cavity midway between the rectum and uterus | g. Vulva |
| | h. Fimbria |

ANSWERS TO REVIEW TEST

- | | | |
|-------|--|-----------------|
| __d__ | 1. Gonads in the female | Ovaries |
| __c__ | 2. Muscular layer of the uterus | Myometrium |
| __h__ | 3. Fringe bordering opening of the fallopian tube | Fimbria |
| __a__ | 4. Area between the vagina and anus | Perineum |
| __g__ | 5. External genitalia of female | Vulva |
| __e__ | 6. Ducts through which the ova travel into the uterus | Fallopian tubes |
| __b__ | 7. Region of abdominal cavity midway between the rectum and uterus | Cul de sac |

Male Reproductive System

The male reproductive system, like that of the female, consists of those organs whose function is to produce a new individual, i.e., to accomplish reproduction. This system consists of a pair of testes and a network of excretory ducts (epididymis, ductus deferens (vas deferens), and ejaculatory ducts), seminal vesicles, the prostate, the bulbourethral glands, and the penis.

Scrotum

The scrotum is a skin-covered pouch of muscle and fascia suspended on the outside of the body. It is one of the supporting structures of the male reproductive system. The scrotum is divided internally into two (left and right) sacs by a septum (partition) so that each sac contains a testis, epididymis, and the lower part of the spermatic cord.

Testes

The testes are two small ovoid glands, male gonads, which lie in the scrotum. These glands are not developed within the scrotal sac, but descend from the abdominal cavity during fetal development.

A thick fibrous capsule (tunica albuginea) encases each testis, extensions of which (septa) partition the interior into lobules. Each lobule contains tiny coiled seminiferous tubules and many interstitial (Leydig) cells which lie between the seminiferous cells. The interstitial cells are glandular cells that produce the hormone testosterone.

The primary functions of the testes are:

- Production of male reproductive cells by the seminiferous tubules (spermatozoa or sperm)
- Secretion of hormones, mainly testosterone, by the interstitial cells of Leydig.

Testosterone is an androgen secreted by the Leydig cells of the testicle. Testosterone is responsible for the development of male secondary sex characteristics and genital growth; it also influences the retention of nitrogen, potassium, phosphorus, and calcium, required for building protoplasm. Androgens also have important growth-regulating function.

Q25

The male gonads consist of a pair of _____ enclosed in a sac called the _____ lying outside of the body cavity.

Q26

A major hormone secreted by the interstitial cells of the testes is _____. It is responsible for the development of the male sex characteristics.

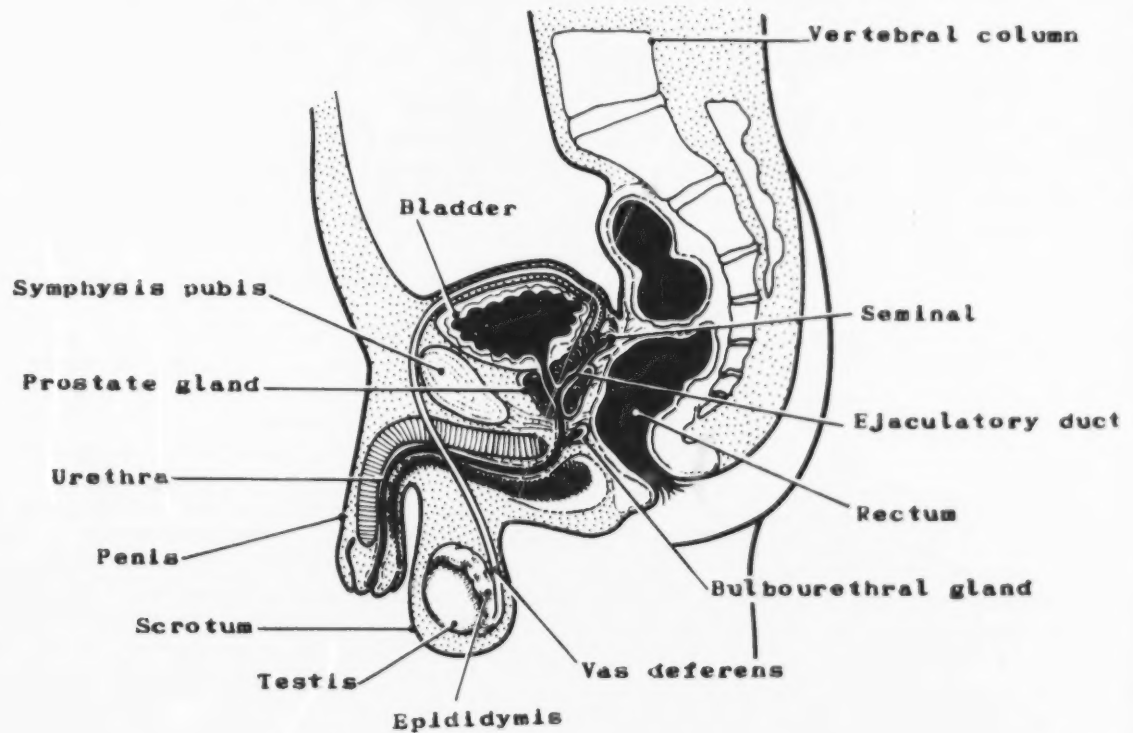
Answer: Q25

The male gonads consist of a pair of testes enclosed in a sac called the scrotum lying outside of the body cavity.

Answer: Q26

A major hormone secreted by the interstitial cells of the testes is testosterone. It is responsible for the development of the male sex characteristics.

Figure 11. MALE PELVIS (sagittal view)



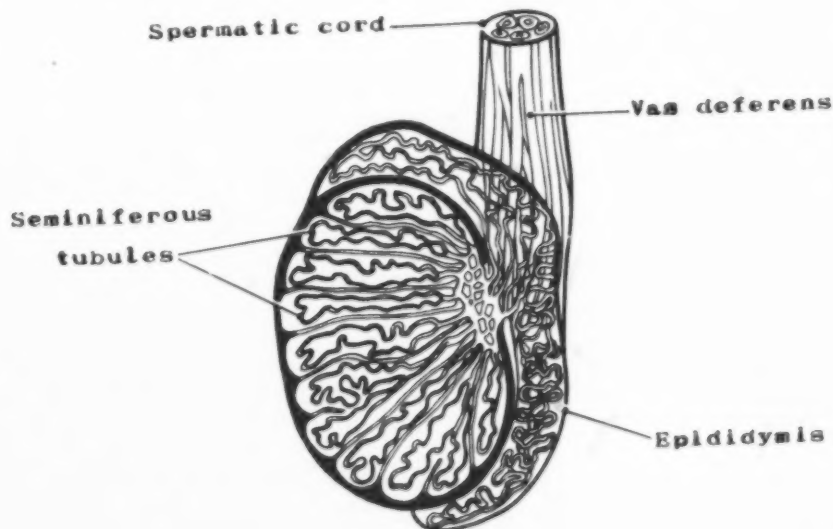
The internal structure of the testis is composed of seminiferous tubules. The seminiferous tubules are narrow, coiled tubules located within the lobules of the testis and composed of parenchymal tissue. Thus, these tubules perform the essential, active work of the organ, that is, production of the sperm cells by two types of cells: 1) the spermatogenic cells and 2) the Sertoli cells which support and protect the developing sperm cells and may even contribute to their nourishment. The Sertoli cells are resistant to heat, radiation, and other agents that prove toxic to germ cells.

Epididymis. Each epididymis consists of a single coiled tube or duct encased in a fibrous covering. It is about 20 feet long with a very small diameter and lies along the top and side of the testis. The sperm cells are temporarily stored in the epididymis after leaving the testis.

Vas deferens. The vas deferens (seminal duct or ductus deferens) is really an extension of the epididymis. It carries sperm from the epididymis to the urethra. The vas deferens passes from the scrotal sac through the opening of the pelvic body wall called the inguinal canal and into the pelvic cavity. There it extends over the top and down the posterior surface of the bladder where it joins the duct from the seminal vesicle on each side to form the ejaculatory ducts. These short tubes, the ejaculatory ducts, pass through the prostate gland and terminate in the prostatic portion of the urethra.

The aggregate of vas deferens and associated blood vessels, lymphatics, and nerves is bound within a connective tissue sheath called the spermatic cord.

Figure 12. TESTIS (sagittal view)



Q27

Match the structure on the left with its function on the right.

- | | |
|-------------------------------|--|
| ----- 1. Epididymis | a. Narrow tubes which carry sperm from the epididymis to the urethra |
| ----- 2. Vas Deferens | b. Narrow, coiled tubules in the testes which produce sperm |
| ----- 3. Seminiferous tubules | c. Tube located on top of each testis, which carries and stores sperm cells before they enter the vas deferens |

Q28

The ----- are the parenchymal (essential) tissue of the testes because they produce the sperm.

Answer: Q27

--c-- 1. Epididymis

Tube located on top of each testis which carries and stores sperm cells before they enter the vas deferens

--a-- 2. Vas deferens

Narrow tubes which carry sperm from the epididymis to the urethra

--b-- 3. Seminiferous tubules

Narrow, coiled tubules in the testes which produce sperm

Answer: Q28

The seminiferous tubules are the parenchymal (essential) tissue of the testes because they produce the sperm.

Seminal Vesicles

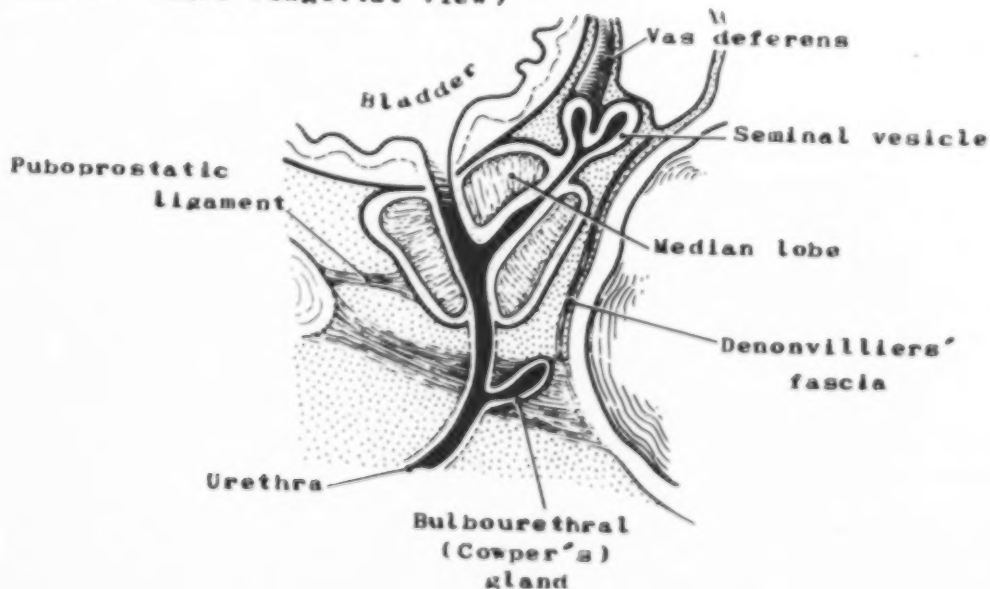
The seminal vesicles are two glands located on the posterior surface of the urinary bladder between the bladder and the rectum. They secrete a substance that nourishes the sperm cells. Approximately 30 percent of the semen is composed of the secretion produced by the seminal vesicles.

Prostate Gland

The prostate gland is located on the inferior surface of the urinary bladder encompassing the prostatic portion of the urethra. It lies behind the symphysis pubis (to which it is connected by the puboprostatic ligament), above the urogenital diaphragm (pelvic floor), and in front of the rectum. It is separated from the rectum by Denonvilliers' fascia. The adult prostate weighs about 20 grams and is typically divided into three lobes: the right and left lateral lobes and the middle lobe. These lobes consist of alveoli lined with columnar epithelium encased in a thin capsule of connective tissue and embedded in a thick fibromuscular stroma. The prostate secretes an alkaline substance which constitutes the largest part (60 percent) of the seminal fluid. This establishes a suitable pH environment for sperm reaching the vagina and protects the ejaculated semen from mechanical damage. The seminal fluid is drained from the alveoli by a system of branching ducts which open into the prostatic portion of the urethra.

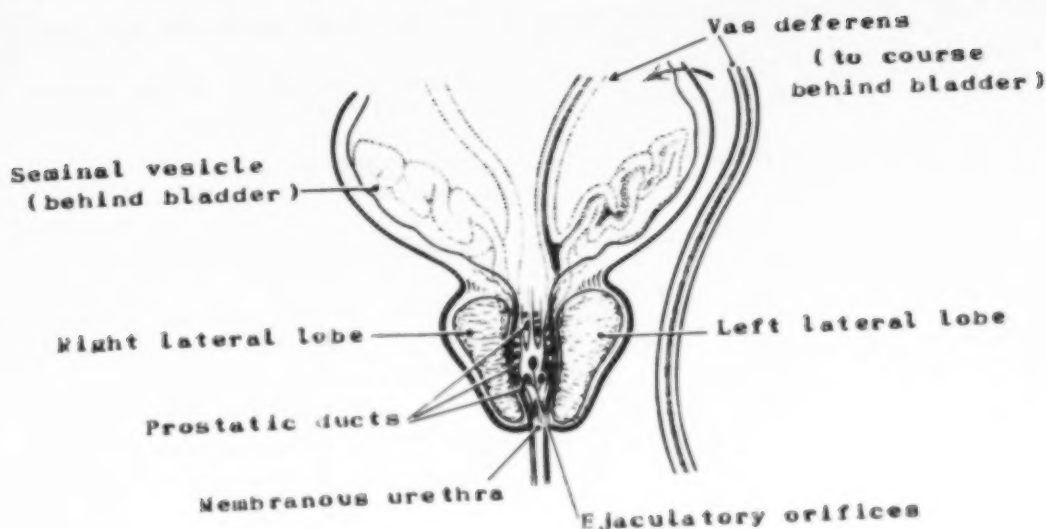
Acid phosphatase is present in the prostatic secretions. Patients with prostatic carcinoma which is still confined within the prostatic capsule usually have a normal serum acid phosphatase level. However, elevated serum levels are seen in patients with carcinoma of the prostate that has extended beyond the prostatic capsule. Acid phosphatase determination is used diagnostically to help determine the spread of disease. See page 49 of Book 5 for normal values.

Figure 13. PROSTATE GLAND (sagittal view)



Denonvilliers' fascia--a portion of the rectovesical fascia between the rectum and prostate gland

Figure 14. PROSTATE GLAND (frontal view)



Relationship of Prostatic Hypertrophy, Hyperplasia, and Prostatic Cancer

Hypertrophy means an increase in size of the prostate due to the increase in the size of the individual cells. In contrast, hyperplasia means an increase in the size of the prostate due to an increase in the number of its cells.

Benign prostatic hypertrophy (enlargement of the prostate) is very common in elderly men. Its exact etiology is not known, although there is some evidence to show that part of it is hormonally mandated. Benign prostatic hypertrophy increases with age as does prostatic cancer; and both require testosterone to grow and divide. In general, prostatic cancer originates in the periphery of the prostate where benign prostatic hypertrophy occurs. That is why it is possible for the physician to palpate these tumors via the rectum. A clinical diagnosis of benign prostatic hypertrophy may be made when a man has symptoms of prostatic disease. Then a TUR is done, and only then may a diagnosis of cancer be made based on the increase in the number of cells, hyperplasia.

Bulbourethral (Cowper's) Glands

The Cowper's glands are located below the prostate on either side of the membranous urethra. They resemble peas in both size and shape. A duct about 2.5 cm long connects each of them with the urethra. Cowper's glands, like the prostate, secrete an alkaline, mucous fluid which makes up about 5 percent of the semen. These glands are also supplied with muscular tissue which aids in expulsion of sperm during ejaculation.

Q29

Match the structures on the left with the descriptions on the right.

----- 1. Prostate

a. Glands which nourish sperm cells by their secretions

----- 2. Bulbourethral

b. Gland which secretes an alkaline substance (60 percent of seminal fluid) providing protective environment for sperm

----- 3. Seminal vesicles

c. Glands which aid in ejaculation because of their muscular tissue

Answer: 029

--b-- 1. Prostate

Gland which secretes an alkaline substance (60 percent of seminal fluid) providing a protective environment for sperm

--c-- 2. Bulbourethral

Glands which aid in ejaculation because of their muscular tissue

--a-- 3. Seminal vesicles

Glands which nourish sperm cells by their secretions

Penis

The penis consists of erectile and connective tissue sheathed in skin. There are three distinct bands of the erectile tissue within the penis: the two corpora cavernosa and the single corpus spongiosum. At the distal end is the glans penis over which there is a double fold of skin called the prepuce or foreskin. The penis contains the penile (spongy or cavernous) segment of the urethra which is the terminal duct for both the urinary and the reproductive tracts in the male.

The penile blood supply is from the internal iliac and femoral arteries by way of the pudendal arteries. Blood drains to the internal iliac veins. During erection, the blood vessels of the penis undergo a change; the arteries become dilated and the veins constricted.

The penis serves two purposes:

- An excretory organ for liquid wastes
- The male copulatory organ.

Regional Lymph Nodes

The regional lymph node drainage for the prostate is:

- Internal iliac (hypogastric)
- External iliac
- Obturator
- Sacral (lateral, presacral, promontory (Gerota's) or NOS)
- Periprostatic
- Pelvic, NOS

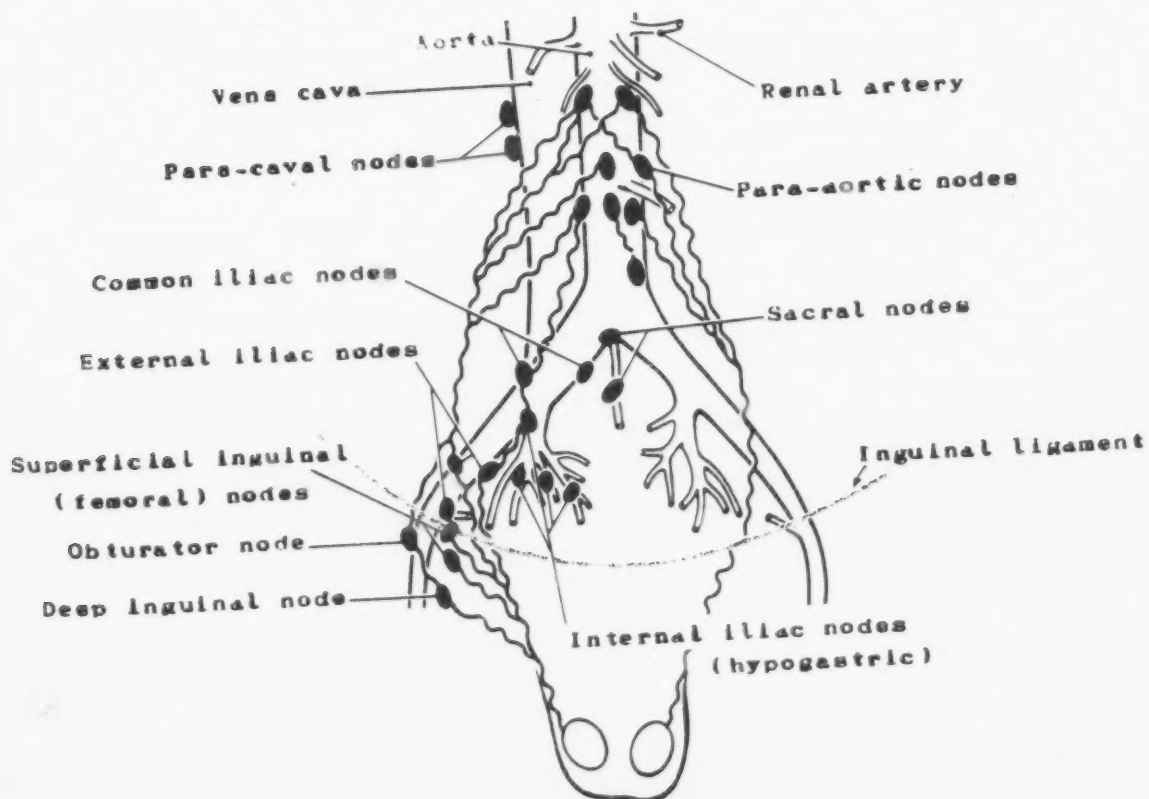
The regional lymph node drainage for the testis is:

- Para-caval
- Para-aortic (retroperitoneal)
- External iliac

The regional lymph node drainage for the penis is:

- External iliac
- Internal iliac (hypogastric)
- Superficial inguinal (femoral)
- Deep inguinal: Rosenmuller's or Cloquet's node

Figure 15. LYMPHATIC DRAINAGE OF THE PROSTATE AND TESTES



Malignant Tumors

The most common malignant neoplasms which occur in the male reproductive system are as follows:

- Adenocarcinoma of the prostate gland, diagnosed primarily in men over 65 years of age.
- Testicular tumors occurring primarily in young men. The classification of testicular tumors is highly controversial and complicated by the frequent occurrence of tumors of mixed cell types. Tumors arising in the germinal epithelium (germ cell types) account for 97 percent of testicular tumors. The most frequent histologic types are as follows:

Seminoma is the most common testicular tumor. It also has the best prognosis as it is slow to spread. Foci of the more malignant types of germ cell tumors, embryonal carcinoma and choriocarcinoma, may be found in the seminoma. Then the prognosis is similar to the more malignant tumor rather than to the pure seminoma. Variants of seminoma are the anaplastic type of seminoma and the spermatocytic seminoma, both of which are rare.

Teratocarcinoma or malignant teratoma is the second most common testicular tumor. Teratomas are tumors of germ cell origin composed of embryonic tissue which is differentiated into bone, hair, teeth, cartilage, and skin. All these types of tissues may be found in the tumor.

Embryonal carcinoma is a more infiltrative type of testicular tumor and consequently has a poorer prognosis. It arises from the primitive or multipotential cells of the germinal epithelium and occurs in a variety of cellular patterns.

Choriocarcinoma (chorioepithelioma) is a rare tumor in its pure form although foci of choriocarcinoma may be found in any of the other germinal tumors. It is highly malignant and metastasizes rapidly. It is derived from primitive cells differentiating as trophoblastic cells. High levels of gonadotropin hormone may be found in the urine with this tumor.

Nongerminial tumors of the testes are extremely rare. Tumors arising in the gonadal stroma include: interstitial cell (Leydig cell) tumors and Sertoli cell tumors. These tumors are seldom malignant.

trophoblastic cells--pertaining to the layer of extraembryonic ectodermal tissue which covers the embryo

Q30

Male hormones are produced primarily in the _____.

Q31

Which of the following are regional nodes for the prostate?

- _____ 1. Para-aortic (retroperitoneal)
- _____ 2. Internal iliac (hypogastric)
- _____ 3. Sacral
- _____ 4. External iliac
- _____ 5. Superficial inguinal

Q32

Which of the following are regional nodes for the testes?

- _____ 1. Portal
- _____ 2. Para-aortic (retroperitoneal)
- _____ 3. External iliac
- _____ 4. Inguinal
- _____ 5. Internal iliac (hypogastric)

Answer: Q30

Male hormones (testosterone) are produced primarily in the testes (or in the interstitial cells of Leydig of the testes).

Answer: Q31

The regional nodes for the prostate are:

- 2 Internal iliac (hypogastric)
- 3 Sacral
- 4 External iliac
- 5 Superficial inguinal

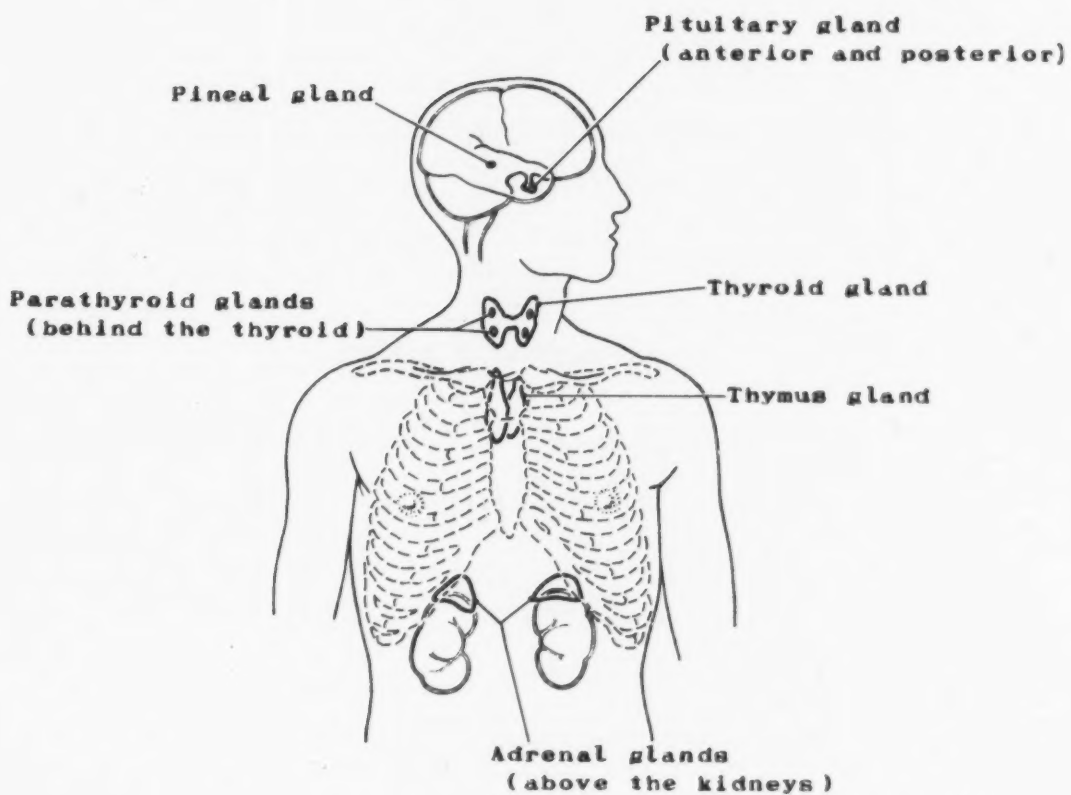
Answer: Q32

The regional nodes for the testes are:

- 2 Para-aortic (retroperitoneal)
- 3 External iliac

SECTION J
THE ENDOCRINE SYSTEM

Figure 16. ENDOCRINE GLANDS



SECTION J

THE ENDOCRINE SYSTEM

The endocrine system is comprised of ductless glands which manufacture and release specific organic secretions called hormones directly into the bloodstream to be carried to various parts of the body where they perform their particular functions. The individual glands are located in widely separated parts of the body and form a system only from a functional point of view. In contrast, the exocrine glands, such as the tear, digestive, and sweat glands release their secretions into ducts leading to the body cavities or outside the body as appropriate. (You may wish to review the pancreas, ovary, and testis which are also part of the endocrine system.)

The Islets of Langerhans of the pancreas are part of the endocrine system and have already been described under the digestive system. The endocrine functions of the ovaries and testes were described under the reproductive system. The remaining endocrine glands and their distinct functions as well as their interesting relationships with each other are described below.

Pituitary Gland (Hypophysis)

The pituitary gland (hypophysis) is controlled by the hypothalamus of the brain and links the nervous system to the endocrine system. Located at the base of the brain behind the eyes in the sella turcica of the sphenoid bone, the pituitary is only the size of a pea. It is referred to as the master gland since it controls all secretions of hormones within the body. The pituitary gland has two lobes, the anterior lobe (the adenohypophysis) and the posterior lobe (the neurohypophysis). Each lobe has definite functions.

The anterior lobe is responsible for producing at least the following hormones:

- Adrenocorticotrophic hormone: ACTH controls the development and secretory activity of the adrenal cortex for secretion of the glucocorticoids (primarily cortisol).
- Thyrotrophic (thyroid-stimulating) hormone: TSH stimulates the growth and development of the thyroid gland and stimulates it to secrete thyroxine and tri-iodothyronine (together called thyroid hormone).
- Follicle-stimulating hormone: FSH stimulates the development of ovarian follicles which secrete estrogen in the female. In the male, FSH stimulates the development of the seminiferous tubules and promotes spermatogenesis.
- Male gonadotrophic hormone (interstitial cell-stimulating hormone): ICSH stimulates the development of the interstitial cells (cells of Leydig) of the testes and the secretion of testosterone.

- Female luteinizing hormone: LH stimulates the secretion of progesterone by the corpus luteum in the ovaries.
- Growth or somatotrophic hormone: GH or STH accelerates growth of bone, muscle, kidney, liver, and adipose tissues.
- Prolactin (luteotrophic hormone): LTH is concerned with initiation and maintenance of lactation in the mammary glands. LH stimulates the ovary to release the developed ovum and prepares the uterus for implantation of a fertilized ovum. It also stimulates formation of the corpus luteum in the ovary, which secretes progesterone and readies the mammary glands for milk secretion.
- Melanocyte-stimulating hormones: MSH and ACTH are thought to produce increased pigmentation of the skin. Structurally the two molecules resemble each other; both contain several of the same amino acids.

The function of the posterior lobe of the pituitary is to produce the following:

- Oxytocin (pitocin) which stimulates the uterine muscles to contract during childbirth and causes the secretion of milk in lactating breasts.
- Antidiuretic hormone (vasopressin) (ADH) which has several effects on the body:

It has an antidiuretic effect stimulating the reabsorption of water by the kidney tubules.

It is thought to have a pressor effect increasing blood pressure by constriction of the arterioles.

It also is believed to have an effect on the smooth muscle of the intestinal tract.

Tumors

Tumors of the pituitary are almost always benign; malignant tumors are rare. These benign tumors may produce hormonal changes in the body or may simulate the symptoms of a brain tumor.

- Adenomas, representing about three-fourths of the pituitary tumors, are of three main types: acidophilic (eosinophilic), basophilic, and chromophobe.
- Cranioopharyngioma (Rathke's pouch tumor) arises along the craniopharyngeal duct and is benign.

Thyroid Gland

The thyroid gland consists of two lateral lobes united by a strip of glandular tissue called the isthmus. It is covered by two capsules: an inner capsule of fibroelastic tissue and an outer capsule continuous with and part of the deep cervical fascia. The thyroid is located on either side of the trachea just below the thyroid cartilage. The unit structure of the thyroid gland is the follicle. A thin, continuous basal membrane surrounds each follicle. Between the follicles are capillaries, fibroblasts, and small bundles of collagenous fibers. This gland produces the hormones thyroxine and tri-iodothyronine which are necessary to maintain a normal level of metabolism in all body cells. These hormones are synthesized in the thyroid gland from iodine. Another hormone produced by the thyroid gland is thyrocalcitonin which aids in maintaining the proper level of calcium in the blood.

The regional lymph nodes for the thyroid are the:

Delphian node
Anterior deep cervical: prelaryngeal, pretracheal, laterotracheal (recurrent laryngeal nerve chain)
Internal jugular (upper and lower deep cervical):
 subdigastric and supraomohyoid
Mediastinal
Retropharyngeal
Cervical, NOS

Tumors

Malignant tumors of the thyroid are primarily of two main types and frequently contain components of each other.

- Papillary adenocarcinoma is the most common thyroid cancer. It is generally well differentiated and characterized by well-defined papillary fronds. Spread is usually via the lymphatics to the cervical lymph nodes. Prognosis is good following excision of the involved lobe(s). Lymph node dissection may be deferred until there is clinical evidence of nodal involvement.
- Follicular adenocarcinoma is the second most common type of thyroid malignancy. It has well-developed follicles resembling normal thyroid tissue. Dissemination is usually via the blood stream to distant sites.
- Medullary carcinoma with amyloid stroma is a rare tumor.
- Anaplastic carcinoma is also rare; it occurs predominantly in older patients.

The most common benign tumor of the thyroid is the adenoma of which there are several types, such as: papillary, follicular, colloid, fetal, and Hurthle cell. These benign tumors are not generally included in the tumor registry unless they are of special interest to the medical staff.

I indicates a change from the 1986 publication including both the "upper" and "lower cervical" nodes in the "internal jugular" chain and calling them "jugulodigastric and jugulo-omohyoid" instead of subdigastric and supraomohyoid for consistency with the American Joint Committee on Cancer's Manual for Staging of Cancer, Third Edition.

Parathyroid Glands

There are four parathyroid glands located immediately behind the thyroid gland beneath its outer capsule. There is, however, little correlation between the functions of the thyroid and the parathyroids. Although each parathyroid is only about the size of a grain of rice, its function is essential to life.

The chief cells of the parathyroid secrete a hormone, parathormone, which maintains the normal phosphorous and calcium levels in the body. Parathormone controls the excretion of phosphorus in the kidney and also mobilizes calcium and phosphorus in bone. It also increases the absorption of calcium from the intestinal tract when necessary.

An excess of parathormone may cause Recklinghausen's disease of the bone (osteitis fibrosa cystica). Excessive parathormone draws calcium from the bone and raises this level in the blood. Pathological fractures may result.

Tumors of the parathyroid are extremely rare; most are benign adenomas.

Pineal Gland

The pineal gland (epiphysis) is located in the brain attached to the roof of the third ventricle (epithalamus). It synthesizes the hormone melatonin which contributes to the process of skin pigmentation.

Tumors of the pineal gland are called pinealomas and are usually benign. Since these tumors are located in the brain, you may be requested to include them in the registry together with benign brain tumors.

Figure 17. THYROID AND PARATHYROID GLANDS

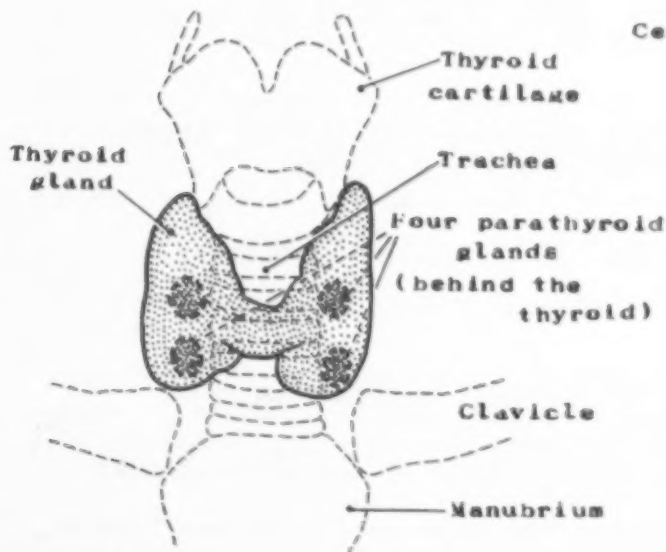
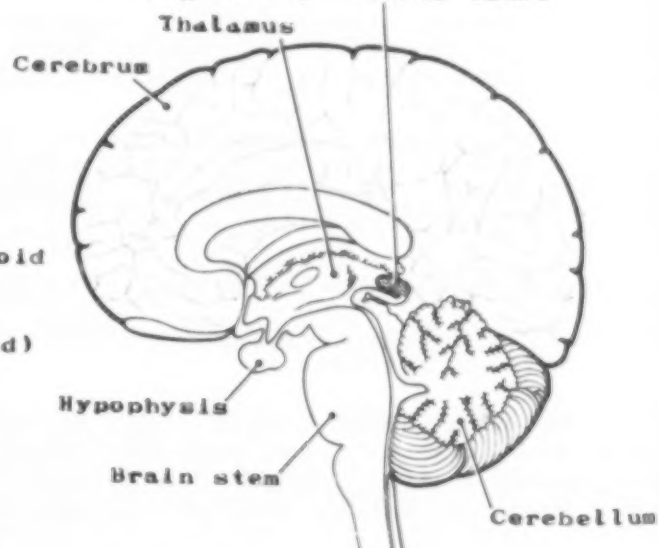


Figure 18. PINEAL GLAND



Adrenal (Suprarenal) Glands

There are two adrenal (suprarenal) glands, about the size of the last digit of the little finger, each paired with and located on top of a kidney and behind the peritoneum. Each adrenal gland consists of two parts, an inner medulla and an outer cortex.

- The adrenal medulla secretes hormones called catecholamines, i.e., epinephrine and norepinephrine. These are hormones produced by stress and were once referred to only as adrenalin.

Epinephrine increases heart rate and cardiac activity, dilates the bronchial tubes, and stimulates the production of glucose from glycogen.

Norepinephrine constricts blood vessels and raises blood pressure.

- The adrenal cortex secretes hormones called steroids. Some of the more important ones are:

Aldosterone, a mineralocorticoid, promotes sodium retention and potassium loss in the urine and vice versa as needed to balance the body fluids.

Cortisol increases the ability of the cells to make new sugars out of fats and proteins. (Cortisone is a hormone similar to cortisol but is produced synthetically.)

Androgens, estrogens, and progestins (male and female hormones) are secreted by the adrenal cortex in small amounts. They promote normal development of bones and reproductive organs.

Tumors

Adrenal tumors may be divided into those arising from the cortical cells and those from the medullary cells of the glands.

- Neuroblastoma, which arises in the medulla, is the most common malignant tumor of the adrenal gland. It is found most frequently in children and young adults and is, in fact, one of the most common childhood tumors. Neuroblastomas can also arise from neural tissue elsewhere in the body.
- Pheochromocytoma and ganglioneuroma are benign, rarely malignant, tumors of the adrenal medulla.
- Adrenal cortical adenocarcinoma arises in the adrenal cortex. Its benign counterpart is the cortical adenoma.

Thymus Gland

The thymus gland is located behind the sternum in the mediastinum. It is large in childhood, but shrinks in adults. Its structure is lymphoepithelial. It is a source of lymphocytes. T lymphocytes mature in the thymus and are involved in cell-mediated immunity, that is, the cells themselves mediate the immune effect. The thymus is also included in the section on the Lymphatic System (see Book 4, Part I).

Tumors of the thymus, thymomas, are rare and most often benign. As a lymphoid organ, the thymus may be primarily or secondarily involved in lymphomas of the mediastinum.

The condition of myasthenia gravis, which is characterized by muscular weakness and fatigue, may be associated with tumors of the thymus.

Other Hormone Producers

The stomach wall secretes a hormone called gastrin which stimulates the blood vessels and secretions of the stomach glands.

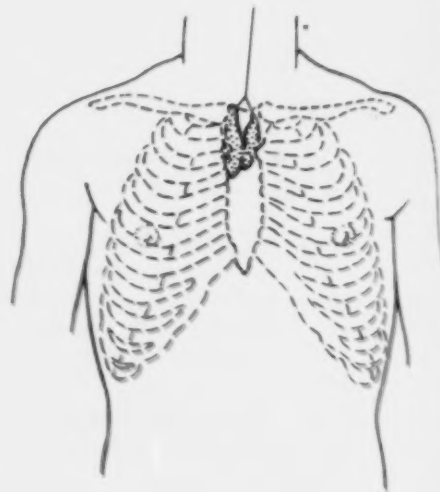
The upper part of the small intestine secretes a hormone called secretin which stimulates the pancreas and causes the gallbladder to contract.

The placenta produces chorionic gonadotropic hormones which help to maintain pregnancy.

Figure 19. ADRENAL GLAND



Figure 20. THYMUS GLAND



Match the terms on the left with the descriptions on the right:

- | | |
|---------------------------|---|
| _____ 1. Hormones | a. An endocrine gland which lies at the base of the brain; the pituitary |
| _____ 2. Hypophysis | |
| _____ 3. Exocrine glands | b. Ductless glands which secrete substances into the bloodstream |
| _____ 4. Isthmus | c. A narrow strip of tissue connecting two parts |
| _____ 5. Endocrine glands | d. Organic secretions originating in a ductless gland and conveyed to another part of the body by the bloodstream |
| _____ 6. Steroids | e. Glands which secrete substances through ducts to the body surface or into body cavities |
| | f. Hormones produced by the adrenal cortex, such as aldosterone, cortisol, and androgens |

02

Match the hormone on the left with the appropriate endocrine gland on the right. The same gland may be selected more than once.

- | | |
|---|-----------------------|
| _____ 1. FSH (follicle-stimulating hormone) | a. Pancreas |
| _____ 2. Androgens | b. Pituitary |
| _____ 3. Cortisol | c. Ovaries |
| _____ 4. Insulin | d. Adrenals (medulla) |
| _____ 5. Thyroxin | e. Testes |
| _____ 6. Parathormone | f. Adrenals (cortex) |
| _____ 7. Epinephrine | g. Thyroid |
| _____ 8. Estrogen | h. Parathyroid |
| _____ 9. Steroids | |

Q3

The endocrine system consists of glandular tissue which secretes
_____ directly into the blood stream from its
_____ (type) glands.

Q4

Match the endocrine glands on the left with their locations in the
body on the right:

- | | |
|----------------------------|--|
| _____ 1. Ovaries (paired) | a. In the mediastinum |
| _____ 2. Testes (paired) | b. On top of each kidney |
| _____ 3. Adrenals (paired) | c. In the middle brain |
| _____ 4. Parathyroids | d. At the base of the brain |
| _____ 5. Thyroid | e. Behind the stomach |
| _____ 6. Pancreas | f. On the dorsal aspect of the thyroid |
| _____ 7. Pineal | g. In the lower abdominal region of the female |
| _____ 8. Thymus | h. On either side of the trachea just below the thyroid cartilage |
| _____ 9. Pituitary | i. Suspended by the spermatic cord and surrounded by the scrotal sac |

Q5

Match the tumor on the left with the typical gland of origin on the
right. The same gland may be selected more than once.

- | | |
|------------------------------------|--------------------|
| _____ 1. Neuroblastoma | a. Pituitary gland |
| _____ 2. Papillary adenocarcinoma | b. Thyroid gland |
| _____ 3. Craniopharyngioma | c. Adrenal gland |
| _____ 4. Follicular adenocarcinoma | |

Answer: Q1

- | | |
|------------------------------|--|
| <u>d</u> 1. Hormones | Organic secretions originating in a ductless gland and conveyed to another part of the body by the bloodstream |
| <u>a</u> 2. Hypophysis | An endocrine gland which lies at the base of the brain; the pituitary |
| <u>e</u> 3. Exocrine glands | Glands which secrete substances through ducts to the body surface or into body cavities |
| <u>c</u> 4. Isthmus | A narrow strip of tissue connecting two parts |
| <u>b</u> 5. Endocrine glands | Ductless glands which secrete substances into the bloodstream |
| <u>f</u> 6. Steroids | Hormones produced by the adrenal cortex, such as aldosterone, cortisol and androgens |

Answer: Q2

- | | |
|--|----------------------------|
| <u>b</u> 1. FSH (follicle-stimulating hormone) | Pituitary |
| <u>e/f</u> 2. Androgens | Testes, adrenals (cortex) |
| <u>f</u> 3. Cortisol | Adrenals (cortex) |
| <u>a</u> 4. Insulin | Pancreas |
| <u>g</u> 5. Thyroxin | Thyroid |
| <u>h</u> 6. Parathormone | Parathyroid |
| <u>d</u> 7. Epinephrine (adrenalin) | Adrenals (medulla) |
| <u>c/f</u> 8. Estrogen | Ovaries, adrenals (cortex) |
| <u>i/e</u> 9. Steroids | Adrenals (cortex), testes |

Answer: A3

The endocrine system consists of glandular tissue which secretes hormones into the blood stream from its ductless glands.

Answer: Q4

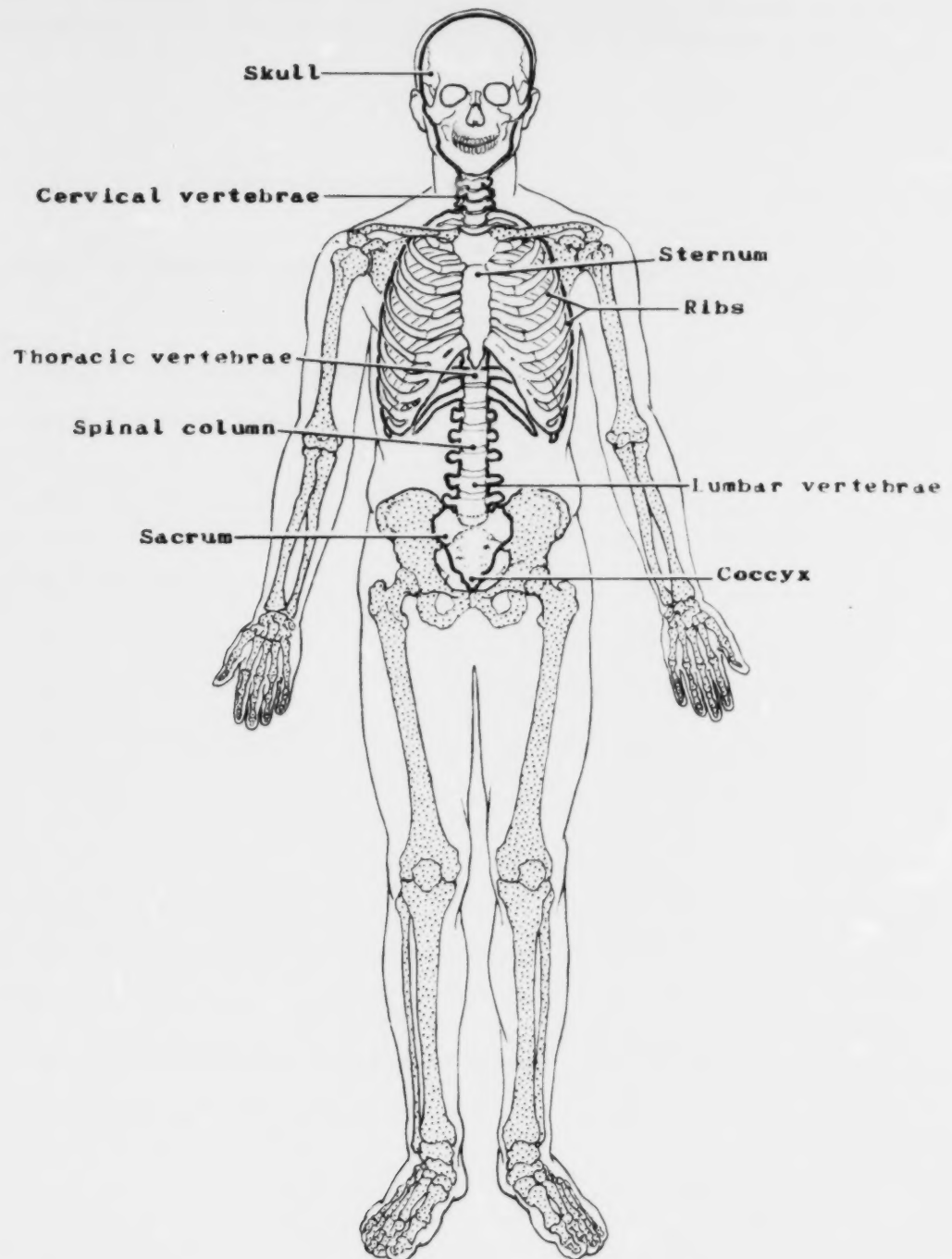
- | | |
|----------------------------|---|
| __g__ 1. Ovaries (paired) | In the lower abdominal region of the female |
| __i__ 2. Testes (paired) | Suspended by the spermatic cord and surrounded by the scrotal sac |
| __b__ 3. Adrenals (paired) | On top of each kidney |
| __f__ 4. Parathyroid | On the dorsal aspect of the thyroid |
| __h__ 5. Thyroid | On either side of the trachea just below the thyroid cartilage |
| __e__ 6. Pancreas | Behind the stomach |
| __c__ 7. Pineal | In the middle brain |
| __a__ 8. Thymus | In the mediastinum |
| __d__ 9. Pituitary | At the base of the brain |

Answer: Q5

- | | |
|------------------------------------|-----------------|
| __c__ 1. Neuroblastoma | Adrenal gland |
| __b__ 2. Papillary adenocarcinoma | Thyroid gland |
| __a__ 3. Craniopharyngioma | Pituitary gland |
| __b__ 4. Follicular adenocarcinoma | Thyroid gland |

SECTION I
THE SKELETAL SYSTEM

Figure 21. AXIAL SKELETON



SECTION K

THE SKELETAL SYSTEM

The skeletal system is composed of bones and cartilage. Most of the bones and much of the cartilage form joints which are held together by ligaments of tough, fibrous connective tissue. Joints can be classified as immovable (synarthrosis), slightly movable (amphiarthrosis), and freely movable (diarthrosis).

There are a total of 206 bones in the adult human body. Eighty of these bones form the upright axis of the body, the axial skeleton, which is the basic framework of the body. It includes the skull, vertebral column, and the bones (ribs) which encase the thorax. The other 126 bones comprise the appendicular skeleton which is made up of bones that are attached or appended to the axial skeleton: the upper and lower extremities (arms and legs) including the shoulder and pelvic girdles (clavicle, scapula, and hip bones). The main bones that compose the skeletal system can be located in Figures 21 and 30.

This complex skeletal system has a variety of functions.

- It provides a supporting framework for the body.
- It affords protection for the vital organs: heart, lungs, brain, spinal cord, as well as sense organs, and soft tissues.
- It provides a leverage system for muscle action with the bones providing attachments for the muscles, ligaments, tendons, and fascia.
- It serves as a storehouse (within the bone) for minerals, and supplies calcium and phosphorus to the blood.
- It contains bone marrow which produces millions of red blood cells and thousands of white cells (hemopoiesis).

ligament--a fibrous band of connective tissue that connects bones to bones serving to support and strengthen joints

tendon--a fibrous cord of connective tissue by which a muscle is attached to bone

fascia--a fibrous sheet of connective tissue covering and separating muscles

Q1

The skeletal system is composed of _____ and
_____ which may be held together by
_____ at their joints.

Q2

Five functions of the skeletal system are:

1. _____
2. _____
3. _____
4. _____
5. _____

Q3

The 206 bones of the skeleton may be grouped into two skeletal divisions:

1. _____ (the basic framework
of the body)
2. _____ (the appendages to
this framework)

Answer: Q1

The skeletal system is composed of bones and cartilage which may be held together by ligaments at their joints.

Answer: Q2

You might have said:

1. It provides a supporting framework for the body.
2. It protects the vital organs.
3. It provides leverage for muscle action.
4. It serves as a storehouse for minerals and supplies calcium and phosphorus to the blood.
5. The bone marrow produces blood cells.

Answer: Q3

The 206 bones of the skeleton may be grouped into two skeletal divisions:

1. Axial skeleton (the basic framework of the body)
2. Appendicular skeleton (the appendages to this framework)

Bone/Cartilaginous Tissue

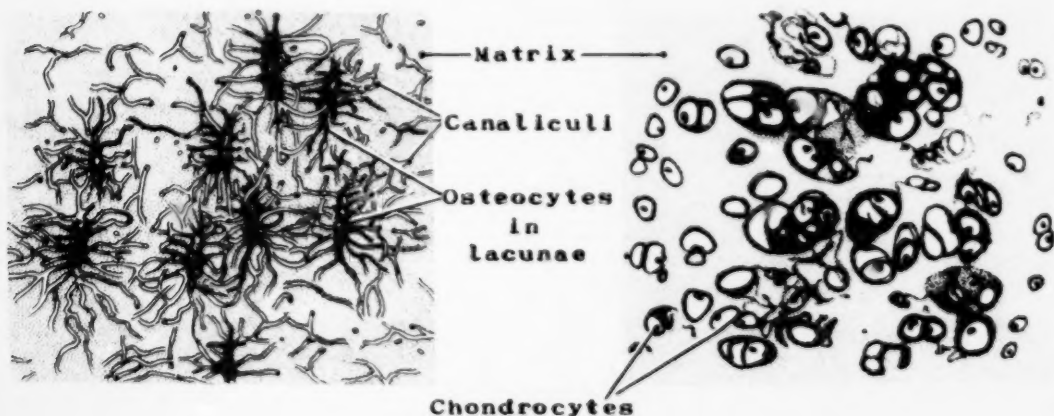
Bone, or osseous tissue, is a form of dense connective tissue in which the intercellular substance, or matrix, is infiltrated with calcium salts. It differs from cartilage in that bone is a vascular tissue permeated with canaliculi. The canaliculi are tiny canals that connect the lacunae (in which bone cells lie) with each other and serve as a transport system (haversian system) between the blood capillaries and the bone cells (see page 102). Tissue fluid in the canaliculi diffuses oxygen and nutrient material from the blood to the bone cells and carries their waste material back to the circulatory system. Thus the bone cells (osteocytes) may remain alive although surrounded by calcified intercellular substance (bone matrix). No bone cell is more than 0.1 mm from a blood capillary.

In contrast, cartilage is nonvascular connective tissue. Its cells (chondrocytes) are nourished by means of blood vessels in the outer layer of perichondrium which covers the surface of the cartilage. There are three types of cartilage:

- Hyaline cartilage, the most abundant, may become calcified and replaced by bone. However, much of it remains uncalcified as part of the ears, nose, larynx, trachea, and larger bronchi, and as a covering of the articulating bones in freely moving joints where it has a cushioning effect.
- Elastic cartilage is rare; it occurs primarily in the external ear and in the epiglottis.
- Fibrocartilage (fibrous cartilage) is found in the areas where tendons insert into bone.

Figure 22. OSSEOUS TISSUE

FIGURE 23. HYALINE CARTILAGE



articulation--the place of union or junction between two or more bones of the skeleton

Q4 One characteristic which distinguishes bone from cartilage is that bone is _____ while cartilage is _____.

Q5 Bone cells are called _____.

Q6 Cartilage cells are called _____.

Q7 Match the types of cartilage on the left with the descriptions on the right:

_____ 1. Hyaline

_____ 2. Elastic

_____ 3. Fibrous

- a. Rare, occurring only in external ear and epiglottis
- b. Occurs in areas of insertion of tendons into bone
- c. Most abundant, may become calcified and be replaced by bone or remain uncalcified as a covering of articulating bones

Answer: Q4

One characteristic which distinguishes bone from cartilage is that bone is vascular while cartilage is nonvascular.

Answer: Q5

Bone cells are called osteocytes.

Answer: Q6

Cartilage cells are called chondrocytes.

Answer: Q7

c 1. Hyaline

Most abundant, may become calcified and be replaced by bone or remain uncalcified as a covering of articulating bones

a 2. Elastic

Rare, occurring only in external ear and epiglottis

b 3. Fibrous

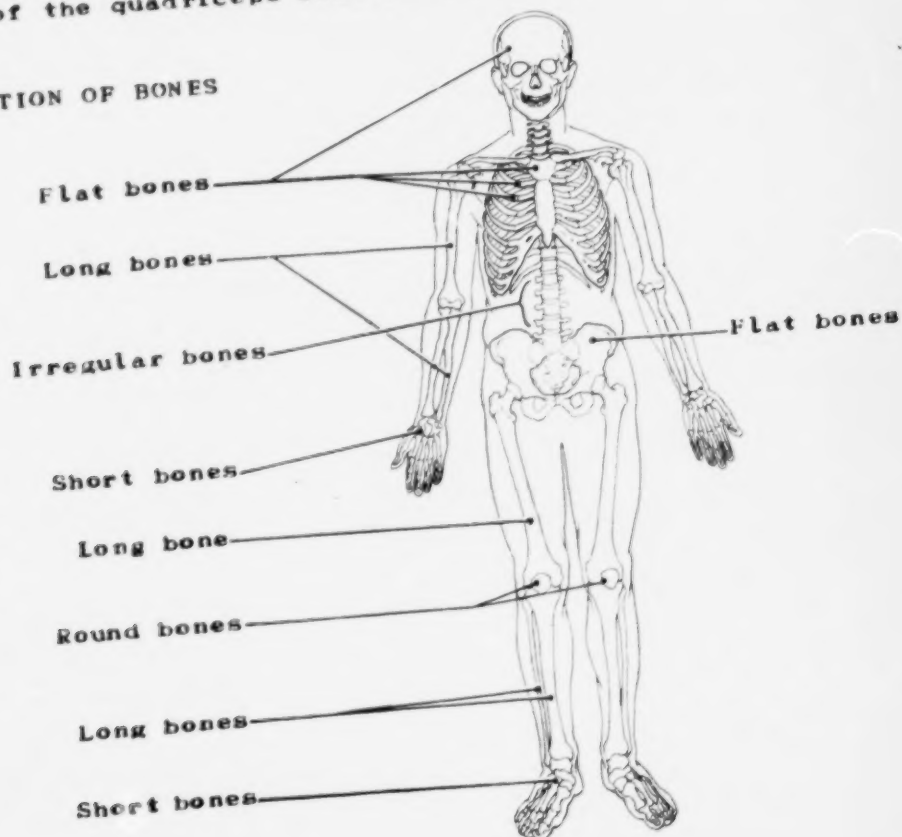
Occurs in areas of insertion of tendons into bone

Classification of Bones

Bones may be classified by shape as follows:

- Long bones are found in the arms and legs. Examples: humerus, radius, ulna, phalanges, femur, tibia and fibula.
- Short bones are short and cuboid or irregular in shape. The three dimensions (length, width, and depth) are all about the same. Examples: wrist and ankle bones (carpal and tarsal).
- Flat bones are protection for the soft body parts. Examples: ribs, sternum, and bones of the pelvis and skull (e.g., temporal, frontal).
- Irregular bones are similar in structure to flat bones, but because of their peculiar shape they are included in their own classification. Examples: vertebrae, sacrum, and ear bones of the skull.
- Round Bones are small, flat, round sesamoid bones, so named because of their resemblance to sesame seeds. Because the number of these bones varies greatly with the individual, only a few are reflected in the total bone count. The function of round bones is to eliminate or reduce friction. Example: The patella or kneecap is the largest sesamoid bone of the body and is embedded in the tendon of the quadriceps femoris muscle at each knee.

Figure 24. CLASSIFICATION OF BONES



Q8

The purpose of the sesamoid bones is to _____.

Q9

Match the following bones with the appropriate descriptions of their shapes:

- | | |
|-------------------|---------------------|
| _____ 1. Femur | a. Short |
| _____ 2. Temporal | b. Flat |
| _____ 3. Sacrum | c. Irregular |
| _____ 4. Carpal | d. Round (sesamoid) |
| _____ 5. Patella | e. Long |

Q10

The _____ consists of both flat and irregular bones.

Answer: Q8

The purpose of the sesamoid bones is to eliminate (or reduce) friction.

Answer: Q9

- e 1. Femur
- b 2. Temporal
- c 3. Sacrum
- a 4. Carpal
- d 5. Patella

Long

Flat

Irregular

Short

Round (sesamoid)

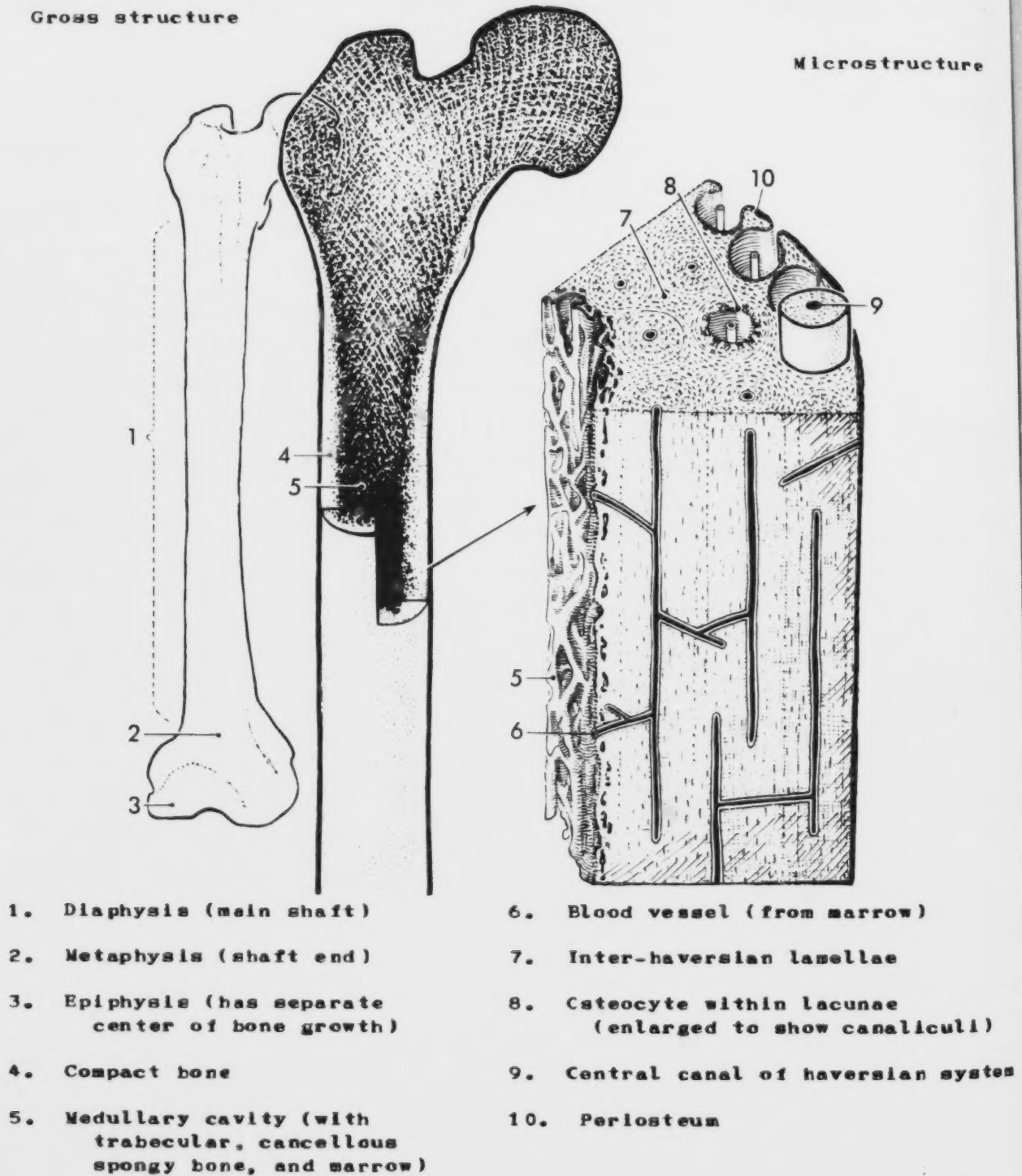
Answer: Q10

The skull consists of both flat and irregular bones.

Figure 25. HAVERSIAN SYSTEM OF THE BONE
ADULT FEMUR

Gross structure

Microstructure



Structure of Bone

Each long bone of the body is made up of several parts (Figure 25). The main shaft is called the diaphysis. It provides strong support without undue weight, and consists mainly of compact bone, although the innermost portion is composed of cancellous, or spongy, bone. At the ends of a bone are structures known as epiphyses which are bulbous in shape, allowing ample space for muscle attachments near joints.

- Short bones consist of a core of cancellous bone encased in a thin layer of compact bone.
- Flat bones are made up of a layer of cancellous bone containing red marrow between two plates of compact bone.
- Irregular bones are similar in structure to short bones in that they are composed of a thin layer of compact bone forming a casing over cancellous bone.
- Round (or sesamoid) bones are made of dense fibrous tissue, cartilage, and bone in varying proportions. They are found embedded in tendons in close relation to articulating surfaces where they modify pressure and reduce friction.

The outside of the bone is covered by a fibrous membrane, the periosteum. Blood vessels, lymphatic vessels, and nerves are present in the periosteum and enter the haversian canals of the compact bone to become vessels of the haversian system permeating the entire bone.

The haversian system is a series of small canals containing blood vessels which bring oxygen and nutrients to the bone and remove waste products such as carbon dioxide.

Bone Marrow

In the adult there are two types of bone marrow: yellow and red. In the center of the diaphysis there is a large space called the medullary cavity which is filled with yellow or fatty bone marrow. Red marrow fills the cancellous spaces in the upper (proximal) epiphyses of the humerus and femur, the iliac crest, body of the vertebra, bones of the skull, (diploe), ribs, sternum, clavicle, and scapula. Red bone marrow is the source of red cells and granular leukocytes as well as platelets and monocytes. Marrow is changed from red to yellow by the replacement of myeloid cells by fat cells, a process which begins soon after birth.

Special lymphocytes, B cells, are formed in the bone marrow. Mature B cells are responsible for the manufacture of antibodies which circulate in blood or other body fluids and respond to antigens found on the surface of viruses and bacteria, thus preventing the spread of infection.

compact bone--continuous dense, hard structure in which spaces can only be distinguished with the aid of a microscope

cancellous bone--spongy or lattice-like structure surrounding intercommunicating spaces filled with bone marrow

haversian--the canal or system named after Clopton Havers (1650-1702), an English anatomist, who first described the structure of osseous tissue

Q11

Name each of the numbered parts of this long bone (see Figure 25):

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

Q12

The outer covering of the bone is known as the _____.

Q13

Periosteum contains _____ vessels, _____ vessels,
and _____ which enter the compact bone to become vessels of
the _____ system.

Q14

Bone marrow is found in the _____ of long bones
and in spaces of _____ bone.

Answer: Q11

1. Diaphysis
2. Epiphysis
3. Periosteum
4. Medullary cavity
5. Bone marrow
6. Compact bone
7. Cancellous (spongy) bone

Answer: Q12

The outer covering of the bone is known as the periosteum.

Answer: Q13

Periosteum contains blood vessels, lymph vessels, and nerves which enter the compact bone to become vessels of the haversian system.

Answer: Q14

Bone marrow is found in the medullary cavity of long bones and in spaces of cancellous bone.

AXIAL SKELETON

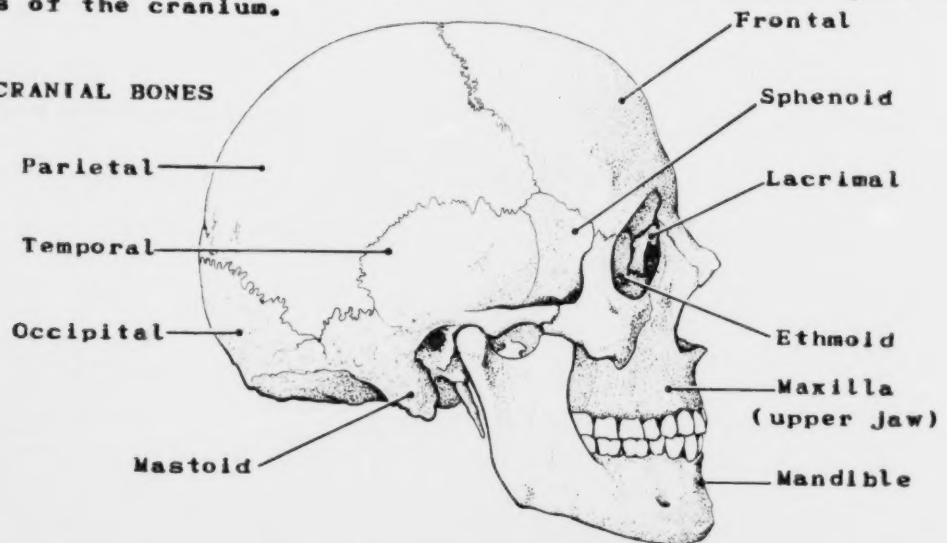
There are a total of eighty bones in the axial skeleton. It is composed of the skull (29 bones), the thorax (25 bones), and the vertebral column (26 bones).

Bones of the Skull. The skull is the skeleton of the face and head. These bones protect the brain and related structures. The skull is composed of twenty-nine bones, eight forming the cranium, fourteen forming the bones of the face, six forming the small bones in the middle ear, and one hyoid bone.

Cranial bones. The cranial bones are the frontal, occipital, sphenoid, ethmoid, two temporal, and two parietal bones. They are joined together by sutures and are immovable.

- The frontal bone is located at the front of the skull. It contains the frontal sinuses and forms the upper rim of the orbit.
- The occipital bone makes up the framework of the lower, posterior part of the skull.
- The sphenoid bone houses the pituitary gland in a depression in its upper surface, the sella turcica, and forms a part of the roof of the nose with its undersurface. It contains the sphenoidal sinuses.
- The ethmoid bone is a light, spongy bone located at the base of the cranium, between the orbits, and at the roof of the nose. It contains the ethmoid air cells (sinuses).
- The temporal bones (2 bones) form part of the sides and part of the base of the skull.
- The parietal bones (2 bones) form the roof and upper part of the sides of the cranium.

Figure 26. CRANIAL BONES



Sutures--fibrous joints in which the apposed bony surfaces are so closely united by a very thin layer of fibrous connective tissue that no movement can occur

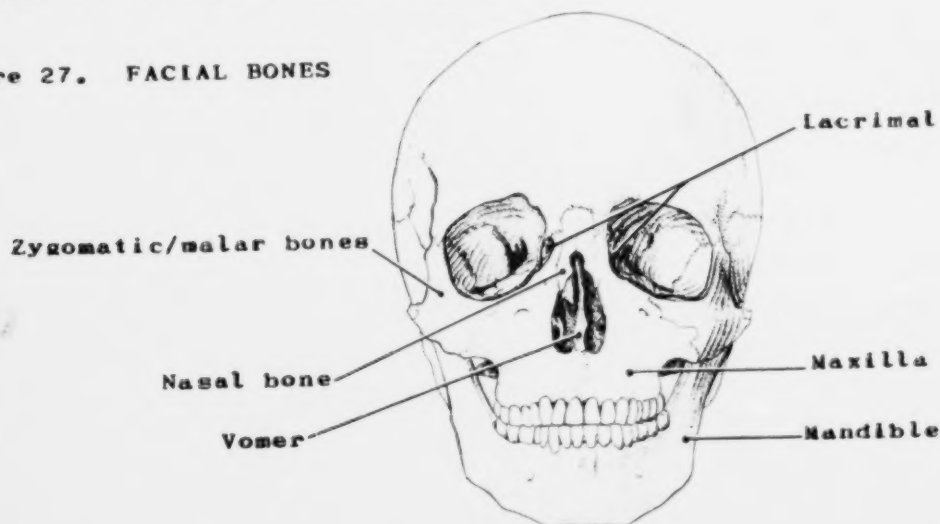
Facial bones. The facial bones are the paired zygomatic, lacrimal, nasal, maxillae, palatine, conchae, and the unpaired vomer and mandible. All the facial bones except the mandible are joined together by suturae so that they are immovable.

- The zygomatic/malar bones form the cheek bones and part of the orbit.
- The lacrimal bones are the smallest and most fragile bones of the face. The tear ducts pass through them in the lacrimal canal.
- The nasal bones support the bridge of the nose.
- The maxillae compose the massive upper jaw bones. Joined by a suture in the median plane, they contain the maxillary sinuses. A condition known as cleft palate results when the two bones do not grow together normally before birth.
- The vomer is a thin, flat bone which forms the lower portion of the nasal septum.
- The mandible is the lower jaw bone. It is movable for chewing and speaking purposes.
- The palatine bone forms part of the wall and floor of the nasal cavity and part of the roof of the mouth.
- The conchae (turbinates) are thin bony plates with curved margins which form the lower part of the lateral wall of the nasal cavity.

Bones of the ear. A chain of three small bones extend across the middle ear on each side: the malleus, the incus, and the stapes. These bones transmit sound waves from the eardrum membrane to the fluid of the inner ear.

Hyoid bone. There is only one hyoid bone; it is U-shaped and located between the root of the tongue and the larynx. Muscles responsible for movement of the tongue are attached to it.

Figure 27. FACIAL BONES



Bones of the Thorax. There are twenty-five bones in the thorax: the sternum, and 12 pairs of ribs.

- Sternum (breast bone) is a flat bone extending down the midline of the chest. It articulates on the sides with the clavicle and ribs.
- Ribs. There are twelve pairs of ribs.

The first seven pairs of ribs articulate with the sternum by cartilaginous attachments. These are called the true ribs.

The last five pairs of ribs are called false ribs because they do not join the sternum directly. Instead, the first three (the 8th, 9th, and 10th) have cartilage which converges before the sternum is reached. The last two are floating ribs which end in the midchest; they are not attached to the sternum at all.

All the ribs are attached to the vertebral column dorsally and form a cage-like structure enclosing and protecting the heart, lungs, and other thoracic structures.

Vertebral column. The vertebral column is made up of 26 bones.

- Cervical vertebrae (7 bones) constitute the skeleton of the neck.
- Thoracic vertebrae (12 bones) are situated between the cervical and lumbar vertebrae. They are attached to the twelve pair of ribs and form part of the posterior wall of the thorax.
- Lumbar vertebrae (5 bones) are situated between the thoracic vertebrae and the sacrum.
- The sacrum is formed by five vertebrae fused into a triangular-shaped bone in the adult.
- The coccyx (tailbone) is formed by four fused vertebrae.

Figure 28. BONES OF THE THORAX
(frontal view)

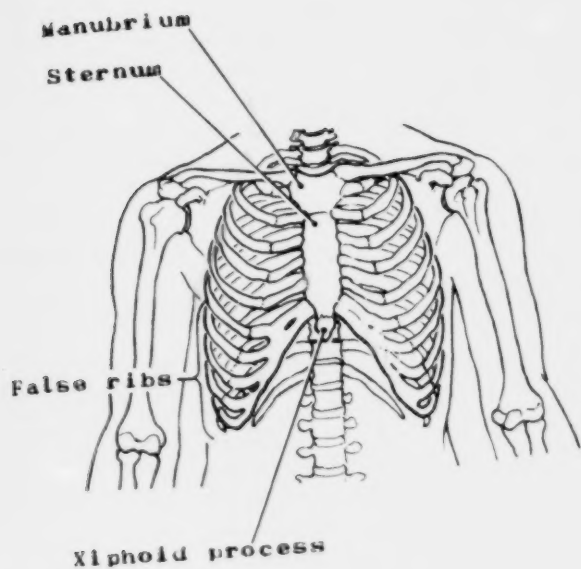
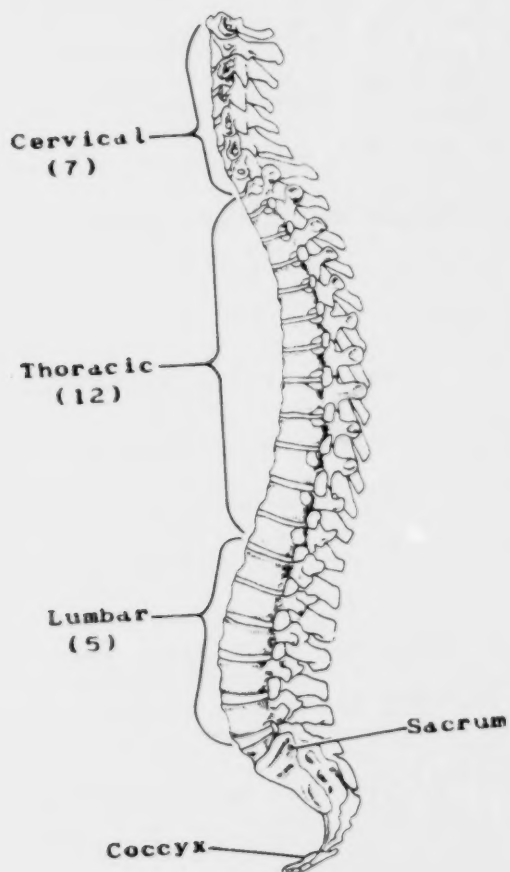


Figure 29. VERTEBRAL COLUMN
(sagittal view)



Q15

Name the cranial bones:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Q16

Name six facial bones:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Q17

Match the bones on the left with the descriptions on the right:

- | | |
|--------------------|---|
| _____ 1. Occipital | a. Bones which form part of the sides and part of the base of the skull |
| _____ 2. Hyoid | b. Houses the pituitary gland and sphenoid sinuses |
| _____ 3. Lacrimal | c. Framework of lower, posterior part of the skull |
| _____ 4. Temporal | d. The tear ducts pass through them. |
| _____ 5. Sphenoid | e. Bone of attachment for muscles which move the tongue |

Answer: Q15

The cranial bones are:

1. Frontal
2. Occipital
3. Sphenoid
4. Ethmoid
5. Temporal (2 bones)
6. Parietal (2 bones)

Answer: Q16

You might have mentioned any six of the following facial bones:

1. Zygomatic
2. Lacrimal
3. Maxillae
4. Nasal
5. Palatine
6. Vomer
7. Mandible
8. Conchae

Answer: Q17

Match the bones on the left with the descriptions on the right.

--c-- 1. Occipital

Framework of lower, posterior part of the skull

--a-- 2. Hyoid

Bone of attachment for muscles which move the tongue

--d-- 3. Lacrimal

The tear ducts pass through them.

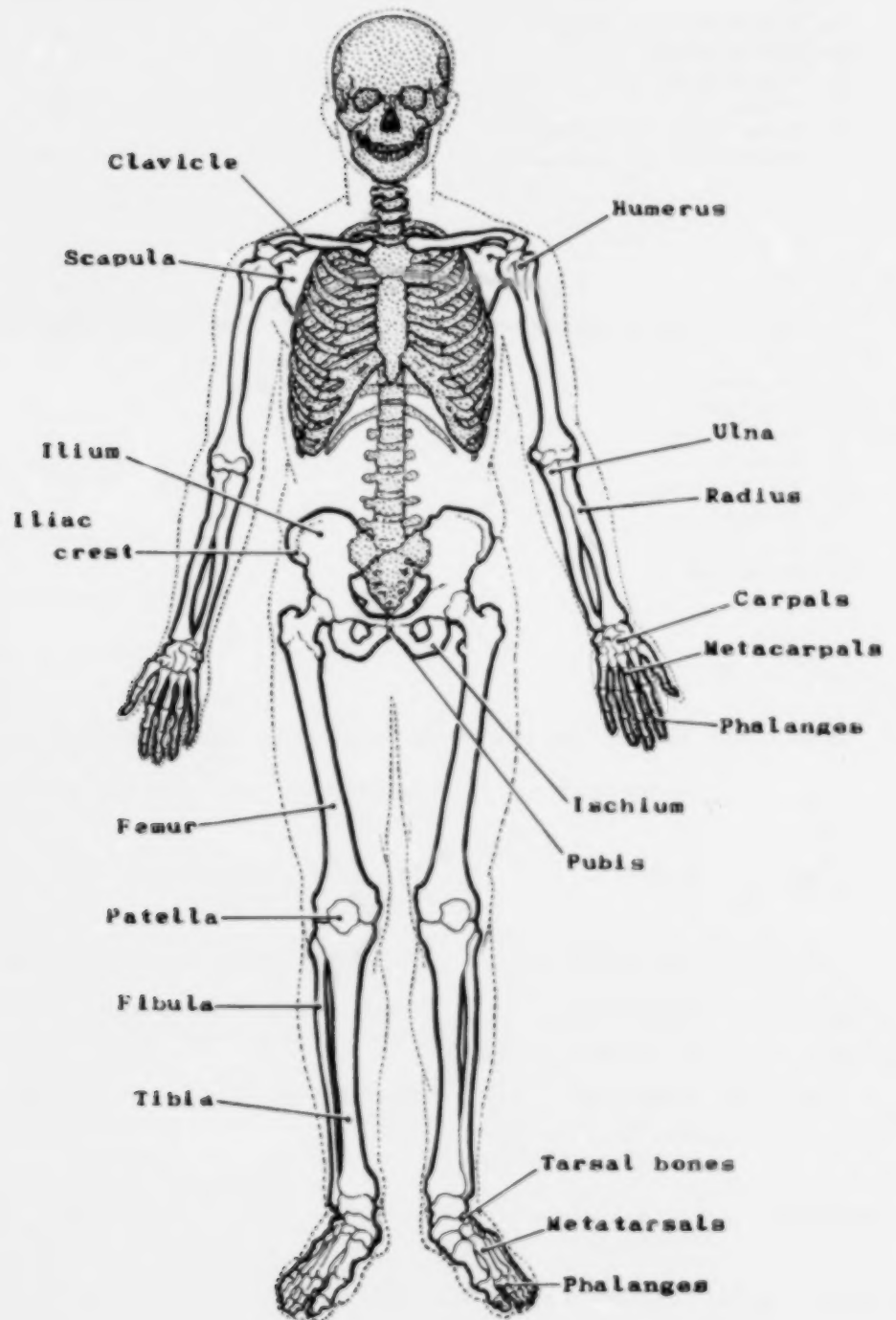
--e-- 4. Temporal

Bones which form part of the sides and part of the base of the skull

--b-- 5. Sphenoid

Houses the pituitary gland and sphenoid sinuses

Figure 30. APPENDICULAR SKELETON



APPENDICULAR SKELETON

The appendicular skeleton is composed of 126 bones.

Upper extremity (32 bones on each side):

- Clavicle: collar bone connects the sternum to the scapula
- Scapula: shoulder blade lies on the upper part of the back
- Humerus: upper arm bone articulates with the scapula at the upper end and with the ulna and radius at its lower end
- Ulna: medial lower arm bone
- Radius: lateral lower arm bone
- Carpals: wrist bones in 2 rows of 4 bones. (total of 8 bones on each hand)
- Metacarpals: bones which form the bony structure of the palm of the hand. (total of 5 bones on each hand)
- Phalanges: bones which form the fingers. Each finger, except the thumb, has three phalanges; the thumb has only two. (total of 14 bones on each hand)

Lower extremity (31 bones on each side):

- Hip bones: ilium, ischium, and pubis form the lateral and anterior walls of the pelvis
- Femur: thigh bone articulates with the tibia at the distal end
- Patella: kneecap
- Tibia (shin bone): The larger of the two lower leg bones articulates with the femur at upper end and with the fibula at both upper and lower ends.
- Fibula: smaller of two lower leg bones
- Tarsals: ankle bones, the highest of which articulates with the tibia and fibula. (total of 7 bones on each foot)
- Metatarsals: bones which form the bony structure of the foot. (total of 5 bones on each foot)
- Phalanges (toe bones): Each toe, except the big toe, has three phalanges; the big toe has only two. (total of 14 bones on each foot)

Malignant Tumors

Bone is derived from three cell lines each of which can produce tumors: osteogenic, chondrogenic, and collagenic. Bone also houses the marrow which contains hematopoietic precursors of myelogenic tumors. All are derived from mesoderm. Only malignant tumors are discussed here.

- Osteogenic Sarcoma (osteosarcoma) is the second most common bone malignancy after myeloma (discussed on p. 115). It occurs mainly in males between the ages of 10 and 20 years. It grows rapidly in the long bones of the extremities and metastasizes quickly via the blood stream to the lungs. It may perforate the periosteum and invade the surrounding soft tissues.
- Periosteal Sarcoma is a rare, slow-growing malignancy. It arises from periosteal fibrous tissue. The posterior aspect of the distal femur is the most common site.
- Giant Cell Tumor, Malignant (malignant osteoclastoma) is a tumor which arises from the connective tissue of the medullary cavity. The malignant type expands rapidly.
- Chondrosarcoma is a tumor arising from the chondrogenic line. There are two distinct types of this tumor: peripheral, which develops on the surface of the bone, and central, which develops in the interior. The peripheral chondrosarcoma tends to affect flat bones such as ilium, sacrum, or scapula. The central chondrosarcoma occurs most often in the femur, tibia, or humerus.
- Ewing's Sarcoma is a highly malignant sarcoma usually occurring in males under 25 years of age. It is multicentric, originates from the reticulum cell, and usually begins in the metaphysis or wide part at the extremity of a long bone.

Closely associated with bone tumors are the following soft tissue tumors:

- Fibrosarcoma and Angiosarcoma: Malignant tumors which come from the connective tissue line. Fibrosarcoma, affecting mainly young adults, causes local bone destruction, particularly of the long bones. Angiosarcoma is a rare tumor arising primarily from capillary endothelial cells (vascular tissue within the bone).

collagenic--containing fibrous connective tissue

Tumors of myelogenic (bone marrow) origin, other than the myeloproliferative disorders, are malignant, for example:

- Multiple Myeloma: A systemic disease found most often between ages 40 to 60 years. It originates in the reticular stem cell in the marrow spaces of the bone and is characterized by overproduction of plasma cells by the marrow. It is the most common bone tumor.

Bone is a common metastatic site for malignant cancer cells which are usually transported by way of the blood stream. The primary sites from which metastases to bone most often occur are breast, prostate, lung, colon, stomach, and urinary bladder.

Q18

Match the descriptions on the left with the terms on the right.

- | | |
|---|----------------|
| _____ 1. A bone which connects the sternum to the scapula | a. Carpals |
| _____ 2. The eight bones of the wrist | b. Patella |
| _____ 3. The five bones which form the bony structure of the hand | c. Hip |
| _____ 4. The kneecap | d. Clavicle |
| _____ 5. The smaller of the two lower leg bones | e. Tarsals |
| _____ 6. The ankle bones | f. Metacarpals |
| _____ 7. The ilium, ischium and pubis | g. Femur |
| _____ 8. The bones of the toes | h. Humerus |
| _____ 9. The shoulder blade | i. Fibula |
| _____ 10. The lateral lower arm | j. Scapula |
| _____ 11. The bone which articulates with the tibia at the distal end | k. Phalanges |
| _____ 12. The bones which form the fingers | l. Tibia |
| _____ 13. The bones which form the long structure of the foot | m. Metatarsals |
| _____ 14. The shin bone | n. Radius |
| _____ 15. The upper arm bone | o. Ulna |
| _____ 16. The medial lower arm bone | |

Q19

Primary malignancies elsewhere in the body frequently metastasize to the bone via the _____.

Q20

Sites from which metastases to bone most frequently occur are:

- | | |
|----------|----------|
| 1. _____ | 4. _____ |
| 2. _____ | 5. _____ |
| 3. _____ | 6. _____ |

Q21

Match each of the tumors on the left with its description on the right.

- | | |
|------------------------------|---|
| ----- 1. Angiosarcoma | a. A tumor composed of both osteogenic and chondrogenic elements |
| ----- 2. Giant cell tumor | b. A rare, slow-growing malignancy arising from fibrous tissue of the periosteum |
| ----- 3. Osteosarcoma | c. A malignant tumor arising in the vascular tissue within the bone |
| ----- 4. Periosteal sarcoma | d. A common bone tumor, second only to myeloma, which occurs mainly in males |
| ----- 5. Osteochondrosarcoma | e. A bone tumor which arises from connective tissue of the medullary cavity |
| ----- 6. Multiple myeloma | f. A highly malignant, multicentric sarcoma originating from the reticulum cell |
| ----- 7. Ewing's sarcoma | g. A systemic disease originating in the reticular stem cell in the marrow spaces of the bone |

Q22

Match the descriptions on the left with one of the terms on the right.

- | | | |
|-------|---|---------------------|
| ----- | 1. Outer membrane covering bone tissue | a. Epiphysis |
| ----- | 2. Flexible, connective tissue found in the ribs, nasal septum, external ear, joints, and respiratory tubes of an adult | b. Diarthrosis |
| ----- | 3. Skull bones: parietal, occipital, frontal, ethmoid, sphenoid, and temporal bones | c. Fascia |
| ----- | 4. Shaft of the long bone | d. Cartilage |
| ----- | 5. Bones found in sternum, pelvis, and ribs; protect soft parts | e. Diaphysis |
| ----- | 6. Bone cell | f. Osteocyte |
| | | g. Tendon |
| | | h. Ligament |
| | | i. Haversian system |
| | | j. Cranial bones |
| | | k. Flat bones |
| | | l. Conchae |
| | | m. Periosteum |
| | | n. Joints |
| | | o. Fossa |
| | | p. Sulcus |

Answer: Q18

- | | | |
|-------|---|-------------|
| __d__ | 1. A bone which connects the sternum to the scapula | clavicle |
| __a__ | 2. The eight bones of the wrist | carpals |
| __f__ | 3. The five bones which form the bony structure of the hand | metacarpals |
| __b__ | 4. The kneecap | patella |
| __i__ | 5. The smaller of the two lower leg bones | fibula |
| __e__ | 6. The ankle bones | tarsals |
| __c__ | 7. The ilium, ischium and pubis | hip |
| __k__ | 8. The bones of the toes | phalanges |
| __j__ | 9. The shoulder blade | scapula |
| __n__ | 10. The lateral lower arm | radius |
| __g__ | 11. The bone which articulates with the tibia at the distal end | femur |
| __h__ | 12. The bones which form the fingers | phalanges |
| __m__ | 13. The bones which form the long structure of the foot | metatarsals |
| __l__ | 14. The shin bone | tibia |
| __h__ | 15. the upper arm bone | humerus |
| __o__ | 16. The medial lower arm bone | ulna |

Answer: Q19

Primary malignancies elsewhere in the body frequently metastasize to the bone via the blood stream.

Answer: Q20

Sites from which metastases to bone most frequently occur are:

1. Breast
2. Prostate
3. Lung
4. Colon
5. Stomach
6. Urinary bladder

Answer: Q21

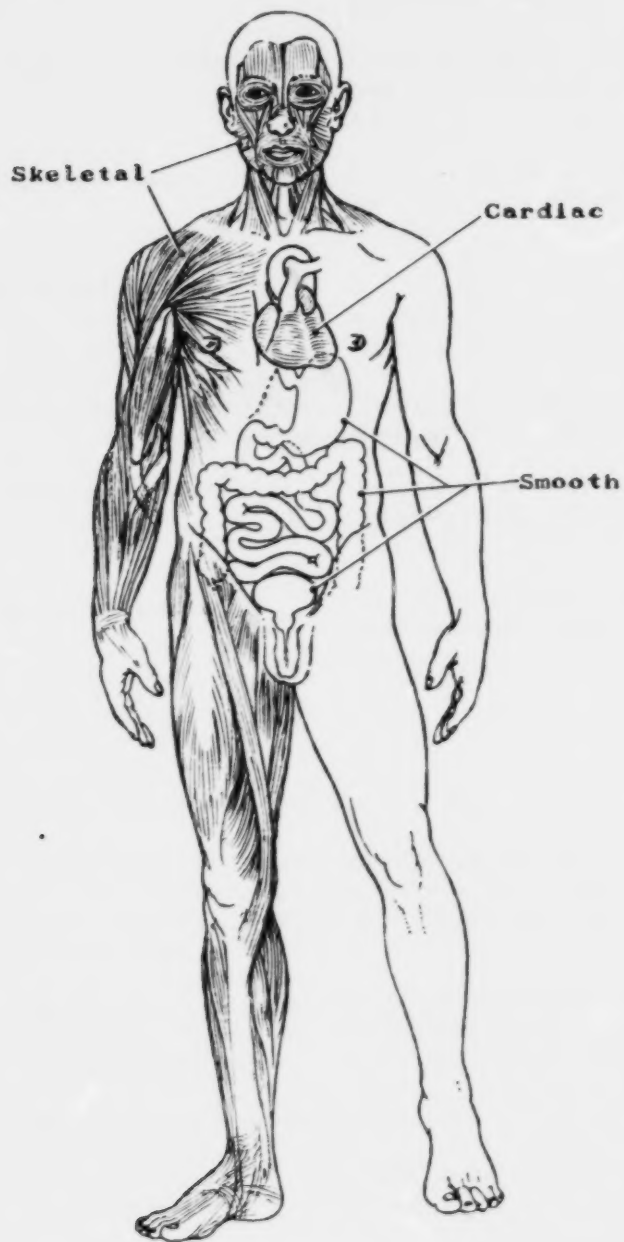
- | | | |
|----------|------------------------|--|
| <u>c</u> | 1. Angiosarcoma | A malignant tumor arising in the vascular tissue within bone |
| <u>e</u> | 2. Giant cell tumor | A bone tumor which arises from connective tissue of the medullary cavity |
| <u>d</u> | 3. Osteosarcoma | A common bone tumor, second only to myeloma, which occurs mainly in males |
| <u>b</u> | 4. Periosteal sarcoma | A rare, slow-growing malignancy arising from fibrous tissue of the periosteum |
| <u>a</u> | 5. Osteochondrosarcoma | A tumor composed of both osteogenic and chondrogenic elements |
| <u>g</u> | 6. Multiple myeloma | A systemic disease originating in the reticular stem cell in the marrow spaces of the bone |
| <u>f</u> | 7. Ewing's sarcoma | A highly malignant, multicentric sarcoma originating from the reticulum cell |

Answers: Q22

- | | | |
|----------|---|---------------|
| <u>a</u> | 1. Outer membrane covering bone tissue | Periosteum |
| <u>d</u> | 2. Flexible, connective tissue found in the ribs, nasal septum, external ear, joints, and respiratory tubes of an adult | Cartilage |
| <u>j</u> | 3. Skull bones: parietal, occipital, frontal, ethmoid, sphenoid, and temporal bones | Cranial bones |
| <u>e</u> | 4. Shaft of the long bone | Diaphysis |
| <u>k</u> | 5. Bones found in sternum, pelvis, and ribs; protect soft parts | Flat bones |
| <u>i</u> | 6. Bone cell | Osteocyte |

SECTION L
THE MUSCULAR SYSTEM

Figure 31. MUSCLE TYPES



SECTION L

THE MUSCULAR SYSTEM

The muscular system is composed of specialized cells called muscle fibers. Their predominant function is contractibility. Muscles, where attached to bones or internal organs and blood vessels, are responsible for movement. Internal movement involves the contraction and relaxation of muscles which are a part of the viscera; external movement is accomplished by the contraction and relaxation of muscles which are attached to bones.

Muscle Types

In the body are found three types of muscle: skeletal, smooth, and cardiac.

- Skeletal muscle, attached to bones, is responsible for skeletal movements. The peripheral portion of the central nervous system (CNS) controls the skeletal muscles. Thus, these muscles are under conscious, or voluntary, control. The basic unit is the muscle fiber with many nuclei. These muscle fibers are striated (having transverse streaks) and each acts independently of neighboring muscle fibers.
- Smooth muscle, found in the walls of the hollow internal organs such as blood vessels, the gastrointestinal tract, bladder, and uterus, is under control of the autonomic nervous system. Smooth muscle cannot be controlled consciously and thus acts involuntarily. The nonstriated (smooth) muscle cell is spindle-shaped and has one central nucleus. Smooth muscle contracts slowly and rhythmically.
- Cardiac muscle, found in the walls of the heart, is also under control of the autonomic nervous system. The cardiac muscle cell has one central nucleus, like smooth muscle, but it also is striated, like skeletal muscle. The cardiac muscle cell is rectangular in shape. The contraction of cardiac muscle is involuntary, strong, and rhythmical.

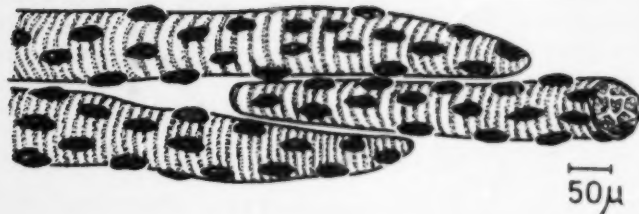
Muscle tissue receives a rich supply of blood which is carried by the arteries into the very substance of the muscle. Most of the arterioles run parallel with muscle fibers and branch off into capillaries at right angles into the fibers.

Muscle tumors tend to spread by way of the blood stream rather than via the lymphatics. Lymph node metastasis does not often occur.

Smooth and cardiac muscle are discussed in more detail with respect to their appropriate systems. This section explains mainly the skeletal muscular system.

Figure 32. HISTOLOGICAL COMPARISONS OF MUSCLE TYPES

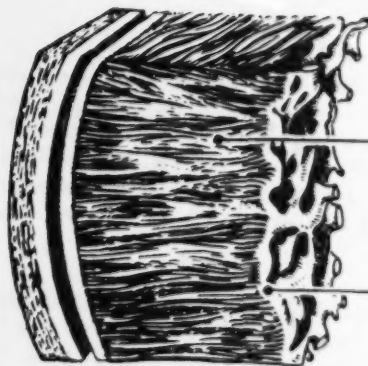
SKELETAL MUSCLE



Voluntary muscles of the mouth attach to maxilla and mandible

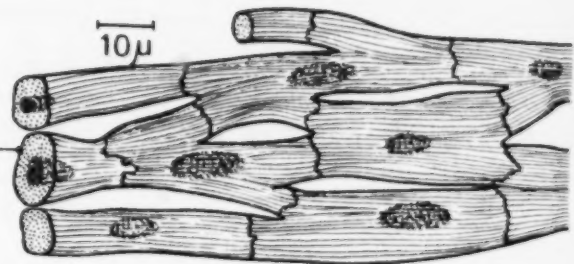


CARDIAC MUSCLE

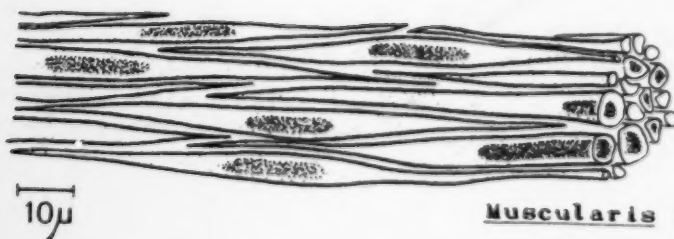


Myocardium
of the heart

Endocardium



SMOOTH MUSCLE



Muscularis propria

Circular layer

Longitudinal layer

Lumen of the
small intestine



Q1 Name the three types of muscle found in the body:

1. _____

2. _____

3. _____

Q2 The two types of muscle that act without voluntary control are _____ and _____ muscle.

Q3 _____ muscle is under voluntary control.

Q4 Which muscle types are described as striated and which is described as nonstriated muscle?

Q5 The _____ and _____ muscle cells have one nucleus, while the _____ muscle cell has many nuclei.

Answer: Q1

The three types of muscle found in the body are:

1. Skeletal muscle
2. Smooth muscle
3. Cardiac muscle

Answer: Q2

The two types of muscle that act without voluntary control are smooth and cardiac muscle.

Answer: Q3

Skeletal muscle is under voluntary control.

Answer: Q4

Skeletal and cardiac muscle are described as striated, while smooth muscle is described as nonstriated.

Answer: Q5

The smooth and cardiac muscle cells have one nucleus, while the skeletal muscle cell has many nuclei.

Tendons, Fascia, and Ligaments

Each muscle merges into a tendon, a tough nonelastic fibrous band of connective tissue which attaches to the fibrous covering of bone (the periosteum), so that the action of the muscle will be transferred to the bone, causing movement of the joint. Perhaps the most well-known is the Achilles tendon, where the posterior muscles of the calf of the leg merge and attach to the calcaneus (heel) bone of the foot.

Fascia is a fibrous sheet of connective tissue which covers and separates muscles. It also encloses the viscera, glands, blood vessels, and nerves. Some fasciae are located superficially under the skin while other fasciae associated with muscles lie deeper within the body.

Ligaments are fibrous bands of connective tissue which anchor bones together thereby strengthening and supporting the joints. Ligaments also serve to hold organs in place.

Q6

☐ True ☐ False

1. Muscles have a rich blood supply, therefore, malignant tumors of muscle often invade blood vessels by virtue of their proximity.

☐ True ☐ False

2. The periosteum is the outer covering of the bone.

☐ True ☐ False

3. The fascia is a tough fibrous band of connective tissue which attaches to the fibrous covering of the bone.

☐ True ☐ False

4. The force of a muscle contraction is transferred to the bone by way of the tendon.

☐ True ☐ False

5. Fasciae are associated only with skeletal muscles.

Q7

Match the descriptions on the left with one of the terms on the right.

_____ 1. A fibrous cord of connective tissue binding muscle to bone

_____ 2. A fibrous sheet of connective tissue covering and separating muscle

_____ 3. Connective tissue binding bones to bones

a. Epiphysis

b. Diarthrosis

c. Fascia

d. Cartilage

e. Ligament

f. Osteocyte

g. Tendon

Answer: Q6

1. True Malignant tumors of muscles often invade blood vessels.
2. True The periosteum is the outer covering of the bone.
3. False Tendons, not fasciae, attach to the fibrous covering of bones.
4. True The force of a muscle contraction is transferred to the bone by way of the tendon.
5. False Fasciae are associated with all muscles as well as the viscera, glands, blood vessels, and nerves.

Answers: Q7

- | | | |
|----------|--|----------|
| <u>a</u> | 1. A fibrous cord of connective tissue binding muscle to bone | Tendon |
| <u>c</u> | 2. A fibrous sheet of connective tissue covering and separating muscle | Fascia |
| <u>d</u> | 3. Connective tissue binding bones to bones | Ligament |

Skeletal Muscles

Some of the skeletal muscles are shown in Figure 31. An extensive list of skeletal muscles is found in your medical dictionary under "muscle." Dorland's dictionary also contains five plates which show most of the more than 600 muscles of the body. Two prominent groups of muscles which have been given characteristic names are the hamstrings (lower extremity) and the biceps (upper extremity).

The five functional characteristics of muscle tissue are:

- Irritability: ability to respond to a stimulus
- Conductivity: ability to transmit impulses
- Extensibility: ability to stretch
- Elasticity: ability to resume former length when the stretching force is removed
- Contractibility: ability to shorten

The three general functions of skeletal muscle are:

- Movement: sometimes locomotion and sometimes movement within a given area
- Heat production: developed by muscle contraction
- Posture: alignment of body parts.

Posture is maintained by a continual pull of muscles on bones in a direction opposite to the pull of gravity, i.e., by the continual partial contraction of muscles, known as muscle tone. Therefore, posture is indirectly dependent on many other factors, such as a normal nervous system and health in general.

The names given to muscles describe one or more of the following features of muscle: action, direction of fibers, location, number of divisions, shape, and points of attachment to bone. Muscles may be classified into groups according to the action or movement performed.

- Flexors decrease the angle in a joint.
- Extensors increase the angle in a joint and also return a body part to neutral position after flexion.
- Abductors move a body part away from the midline.
- Adductors move a body part towards the midline.
- Rotators cause a body part to pivot on its axis.
- Levators/elevators raise a body part.
- Depressors lower a body part.
- Supinators turn the palm upward or forward.
- Pronators turn the palm downward or backward.
- Sphincters reduce the size of an opening.
- Tensors make a body part more rigid.

Malignant Tumors

Malignant tumors of muscle tissue are known as sarcomas. Refer to The International Classification of Diseases for Oncology (8890-8920), p. 33, for a list of myomatous (muscle) tumors.

All sarcomas usually present as firm masses in the subcutaneous tissue or deep within or between muscles. However, there are many different varieties of malignant soft tissue tumors:

- Leiomyosarcoma is a tumor of smooth muscle.
- Rhabdomyosarcoma is a tumor of striated muscle.
- Angiomyosarcoma is a tumor composed of blood vessels and muscular tissue.

Malignant tumors closely associated with muscle tissue:

- Synovial sarcoma is a tumor arising in the tendon sheaths, bursa and joints.
- Fibrosarcoma is a tumor of fibrous tissue which may arise in association with striated muscle or fascia.

Q7

What are the three general functions of the skeletal muscle?

1. _____
2. _____
3. _____

Q8

How is the posture of the body maintained?

- _____
- _____

Q9

What are the functional characteristics of muscle tissue?

1. _____
2. _____
3. _____
4. _____
5. _____

Answer: Q8

The three general functions of skeletal muscle are:

1. Movement
2. Heat production
3. Posture

Answer: Q9

Posture is maintained by continual partial contraction of the muscles.

Answer: Q10

The functional characteristics of muscle tissue are:

1. Irritability
2. Conductivity
3. Extensibility
4. Elasticity
5. Contractibility.

Q11

Match the muscle groups on the left with the descriptions on the right.

- | | |
|---------------------|---|
| _____ 1. Supinators | a. Decrease the angle in a joint |
| _____ 2. Sphincters | b. Move a body part away from the midline |
| _____ 3. Abductors | c. Lower a body part |
| _____ 4. Flexors | d. Turn the palm upward or forward |
| _____ 5. Depressors | e. Reduce the size of an opening |

Q12

Match each description on the left with one of the terms on the right.

- | | |
|--|---------------------|
| _____ 1. Heart muscle, involuntary and striated | a. Fasciae |
| _____ 2. Fibrous sheets of connective tissue which cover the muscles | b. Visceral muscle |
| _____ 3. The hamstring muscles and the bicep muscles | c. Leiomyosarcoma |
| _____ 4. A malignant tumor of smooth muscle | d. Striation |
| _____ 5. A characteristic of skeletal muscle | e. Tendons |
| _____ 6. Connective tissue binding muscle to bone | f. Rhabdomyosarcoma |
| _____ 7. Involuntary, visceral muscle | g. Cardiac muscle |
| | h. Ligaments |
| | i. Skeletal muscle |
| | j. Angiomyosarcoma |
| | k. Smooth muscle |

Answer: Q11

Match the muscle groups on the left with the descriptions on the right:

- d 1. Supinators turn the palm upward or forward.
- e 2. Sphincters reduce the size of an opening.
- b 3. Abductors move a body part away from the midline.
- a 4. Flexors decrease the angle in a joint.
- c 5. Depressors lower a body part.

Answer: Q12

- e 1. Heart muscle, involuntary and striated Cardiac muscle
- a 2. Fibrous sheets of connective tissue which cover the muscles fasciae
- i 3. The hamstring muscles and the bicep muscles Skeletal muscle
- c 4. A malignant tumor of smooth muscle Leiomyosarcoma
- d 5. A characteristic of skeletal muscle Striation
- g 6. Connective tissue binding muscle to bone Tendons

SECTION M
THE NERVOUS SYSTEM

SECTION M

THE NERVOUS SYSTEM

The nervous system provides the integration and control of body processes. It is customarily divided into 1) the central nervous system which consists of the brain and spinal cord and their coverings which are called meninges and 2) the peripheral nervous system which consists of the nerves that connect the brain and spinal cord to the tissues and organs of the body.

Nervous Tissue

Nervous tissue is composed of three types of cells:

- Neuron

The nerve cell (neuron) is the basic structural and functional unit of the nervous system. Each neuron consists of a cell body which contains a large nucleus surrounded by cytoplasm and processes called dendrites and axons. These processes are peculiar to neurons and are responsible for the conduction and transmission of neural information. Dendrites carry impulses toward the cell body; a single axon conducts impulses away from the cell body. Axons (nerve fibers) in the peripheral nervous system may be covered by a myelin sheath and by neurilemma, which is a membranous sheath that covers the axon directly or covers the myelin sheath when it is present. Not only does the myelin sheath increase the speed of nerve impulse conduction, but it insulates and maintains the axon; the neurilemma assists in the regeneration of injured axons. Nerve tissue of the brain and spinal cord has no myelin sheath, nor does it regenerate.

- Neuroglia (glial cells)

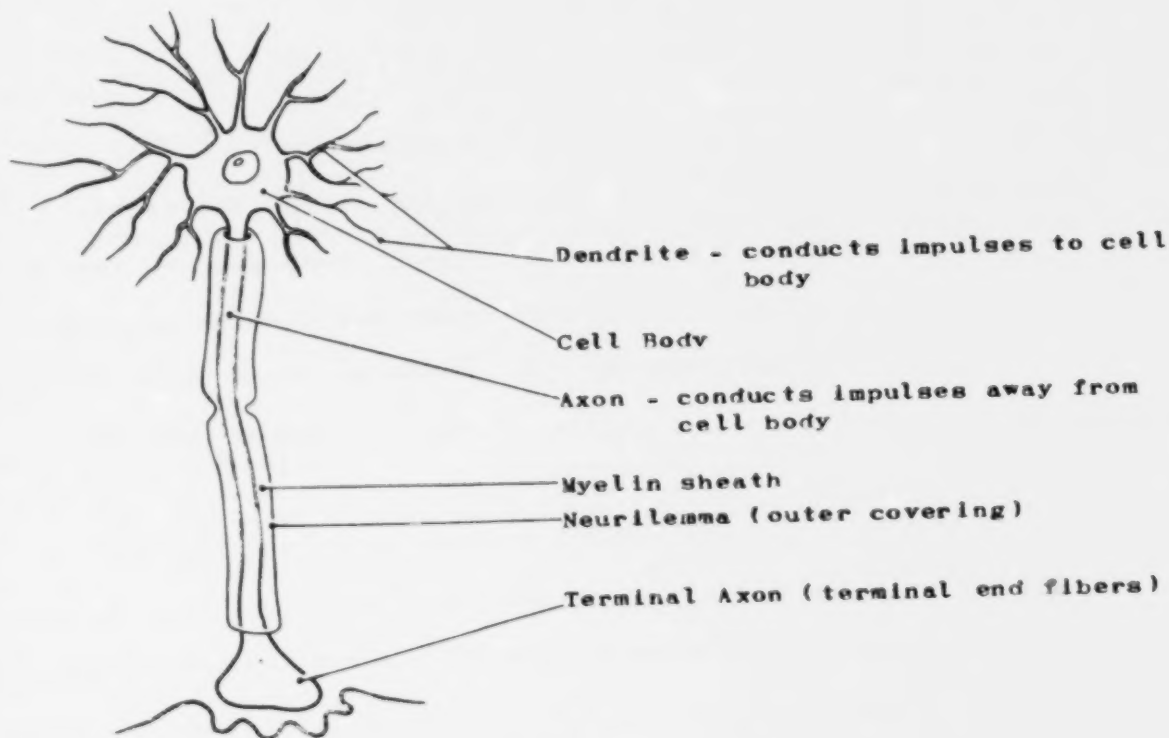
The neuroglial cells of the nervous system provide the connective tissue which binds together the neurons in the central nervous system giving support and protection. They consist of astrocytes, oligodendrites, ependymal cells and microglial cells. Most central nervous system (CNS) tumors arise in the neuroglial cells.

- Schwann cells

The Schwann cells form a sheath (neurilemma) covering the axons of peripheral nerve fibers.

The processes of the neurons (nerve fibers) may serve sensory or motor functions. Sensory nerve fibers carry messages of sensation and feeling from the tissues and organs to the brain and spinal cord. Motor nerve fibers carry messages pertaining to movement from the brain and spinal cord to tissues and organs.

Figure 33. NERVE CELL (neuron)



Q1

The central nervous system is made up of the _____
and the _____.

Q2

The nerves outside the central nervous system comprise the
_____nervous system.

Q3

Match each nerve on the left with its function on the right.

- | | |
|-------------------------|---|
| _____ 1. Motor nerves | a. Carry messages to the brain
from the tissues and organs |
| _____ 2. Sensory nerves | b. Carry messages from the brain
to the tissues and organs |

Q4

A myelin sheath is found only on nerves of the _____
nervous system. What is the significance of the myelin sheath? _____

Q5

Name the parts of the nerve cell:

1. _____
2. _____
3. _____
4. _____
5. _____

Answer: Q1

The central nervous system is made up of the brain and the spinal cord.

Answer: Q2

The nerves outside the central nervous system comprise the peripheral nervous system.

Answer: Q3

- | | | |
|-------|-------------------|---|
| __b__ | 1. Motor nerves | Carry messages from the brain to the tissues and organs |
| __a__ | 2. Sensory nerves | Carry messages from the tissues and organs to the brain |

Answer: Q4

A myelin sheath is found only on nerves of the peripheral nervous system.

The myelin sheath increases the speed of nerve impulse conduction and insulates and maintains the axon.

Answer: Q5

The names of the parts of the nerve cell are as follows:

1. Dendrite
2. Cell body
3. Axons
4. Myelin sheath
5. Neurilemma

CENTRAL NERVOUS SYSTEM

The central nervous system (CNS) consists of the brain (encephalon), spinal cord, and meninges.

Brain

The brain lies within the cranial cavity of the skull. It may be described in terms of three main subdivisions: forebrain, midbrain and hindbrain.

Forebrain

The forebrain consists of the cerebrum (telencephalon) and the diencephalon.

- The cerebrum is the largest part of the human brain, and controls, for example, voluntary muscular activity, speech, thought, memory, vision, taste, and hearing. It is made up of two cerebral hemispheres. The folds on the surface of the brain are known as convolutions. The cerebral hemispheres enclose the lateral ventricles (canals in the interior of the brain filled with cerebrospinal fluid). The two hemispheres are connected by the corpus callosum. Each hemisphere consists of:

1. The cerebral cortex forms the outer layer. It contains the cell bodies of neurons often called the "gray matter" of the brain. (The inner "white matter" is made up of myelinated nerve fibers.)
2. The basal ganglia lie deep within the hemispheres and are responsible for voluntary muscle movement. Basal ganglia are masses of gray matter.
3. Olfactory bulbs (rhinocephalon) lie on the ventral surface of each cerebral hemisphere and are associated with the sense of smell (cranial nerve I).

The cerebrum is divided into lobes designated as frontal, temporal, parietal, and occipital (see Figure 34 on page 141).

- The diencephalon or thalamencephalon connects the cerebral hemispheres with the midbrain and forms the walls of the third ventricle.
 1. The thalamus is an important relay center for sensory fibers on their way to the cerebral cortex; crude sensation and pain may be registered here.
 2. The hypothalamus contains the centers for the autonomic nervous system controlling sleep, water balance, temperature regulation, and secretions from the pituitary gland.
 3. The epithalamus contains the pineal body (gland).

Figure 34. CEREBRUM

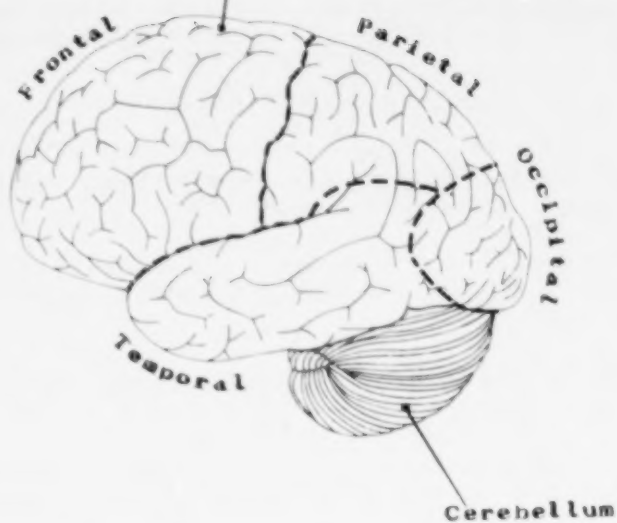
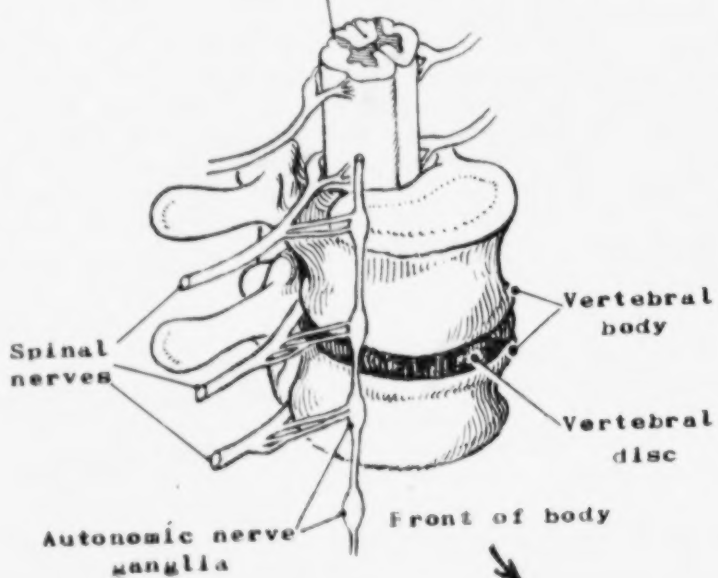


Figure 35. SPINAL CORD



Midbrain (mesencephalon)

The midbrain receives impulses from the eye and ear. It serves as a center for visual and auditory reflexes. It also connects the forebrain to the hindbrain. Cranial nerves III and IV stem from the midbrain.

Hindbrain (rhombencephalon)

The hindbrain consists of the pons, the cerebellum, and the medulla oblongata. It surrounds the fourth ventricle.

- The pons (pons = bridge) bridges the cerebrum and cerebellum. It contains nerve fibers which link the cerebral cortex with the medulla oblongata and the spinal cord.

The nuclei of the cranial nerves V, VI, VII, and VIII are situated in the pons.

- The medulla oblongata controls breathing and heartbeat. It consists of neurons which form the nuclei of the cranial nerves IX, X, XI and XII.
- The cerebellum has centers which are concerned with balance and equilibrium. The function of the cerebellum is coordinating groups of muscles to work together smoothly.

Spinal Cord

The spinal cord lies in the vertebral canal of the spinal column and extends from the medulla oblongata to the lumbar vertebrae. There are thirty-one pairs of spinal nerves, both motor and sensory. The spinal cord also serves as a reflex center.

In certain areas of the spinal cord the anterior rami (branches) of the spinal nerves combine to form networks of nerve fibers called plexuses. These are the cervical (1st four cervical spinal nerves), brachial (last four cervical and 1st thoracic spinal nerve), lumbar (1st four lumbar nerves), sacral (4th and 5th lumbar and 1st sacral nerve), pudendal (3rd and 4th sacral nerves), and coccygeal (5th sacral and coccygeal nerve) plexuses.

Meninges

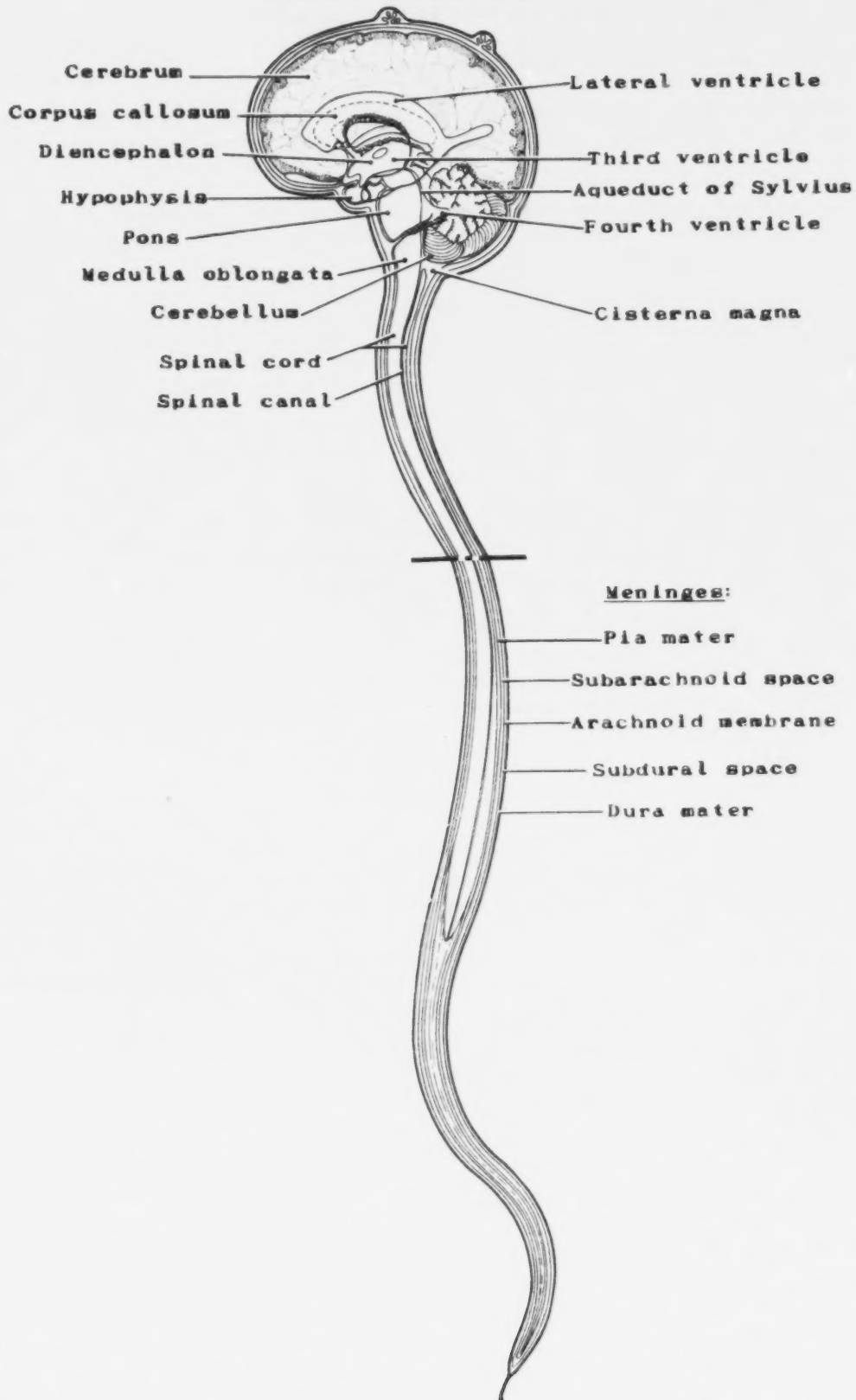
The meninges are comprised of three membranes which surround the brain and spinal cord. The dura mater is a thick, tough membrane lining the skull. The pia mater is the thin innermost layer which is in contact with the brain. The arachnoid mater lies between the two; it is a thin covering and contains the blood vessels.

Cerebrospinal Fluid (CSF)

The cerebrospinal fluid is produced by the choroid plexus of the four ventricles. It circulates throughout the brain and spinal cord.

choroid plexus--vascular fringelike folds in the pia mater of the cerebral ventricles

Figure 36. DIAGRAM SHOWING BRAIN, VENTRICLES, MENINGES AND INTERMENINGEAL SPACES



PERIPHERAL NERVOUS SYSTEM

The peripheral nervous system (PNS) consists of nerves and ganglia outside the brain and spinal cord. It (PNS) serves to interconnect all other tissues with the central nervous system.

Peripheral nerves are connected to the spinal cord by two roots: the anterior, ventral, or motor root and the posterior, dorsal, or sensory root.

The peripheral nervous system innervates all voluntary muscles and transmits the sensory impulses from the whole of the body. It is largely under conscious (cerebral) control.

Thus, injury or disease of peripheral nerves usually results in both sensory and motor loss. Because of the regenerative ability of the neurilemma, however, eventual recovery is possible if the nerve is largely intact or the ends of the divided nerve are placed close together.

Autonomic Nervous System

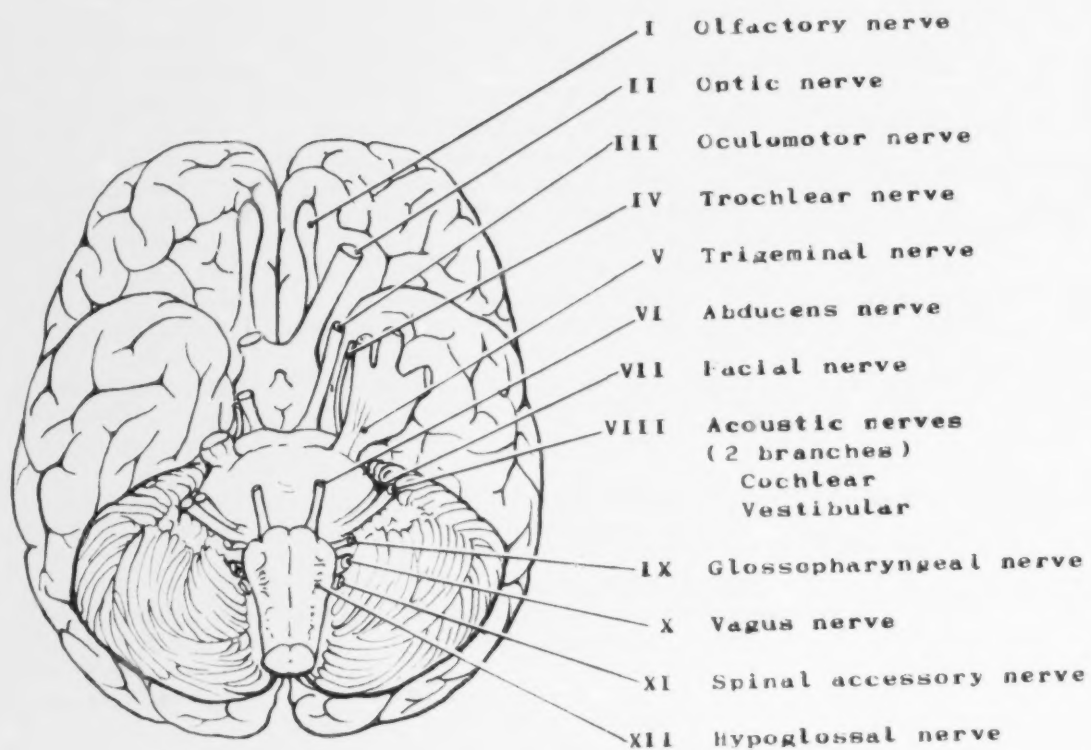
The autonomic nervous system is a subdivision of the peripheral nervous system and carries impulses from the brain and spinal cord to body organs. It controls and regulates largely by involuntary action of the glands, heart, and smooth muscle tissues (e.g., smooth muscle in the intestines and blood vessel walls).

Autonomic nerves arise at different levels of the central nervous system. The autonomic nerves arising from the spinal cord comprise the sympathetic (thoracolumbar) and parasympathetic (craniosacral) nervous systems.

Spinal Nerves

There are thirty-one pairs of spinal nerves: eight pairs of cervical nerves, twelve pairs of thoracic nerves, five pairs of lumbar nerves, five pairs of sacral nerves, and one pair of coccygeal nerves. All spinal nerves carry impulses between the spinal cord and the abdomen, chest, and extremities.

Figure 37. CRANIAL NERVES



Cranial Nerves

The cranial nerves carry impulses to or from the brain.

<u>Cranial Nerves</u>	<u>Motor Function</u>	<u>Sensory Function</u>
I Olfactory	None	Smell
II Optic	None	Sight
III Oculomotor	All eye muscles except the superior oblique and the external rectus; also innervates the iris and ciliary body	None
IV Trochlear	Superior oblique muscle Eye movement	None
V Trigeminal	Muscles of mastication	Sensations from eye, face, sinuses, and, teeth
VI Abducens	External rectus muscle Eye movement	None
VII Facial	Facial muscles, sub-maxillary and sublingual salivary glands	Tactile and taste sensations from the anterior 2/3's of tongue and soft palate
VIII Acoustic (2 branches) Cochlear Vestibular	None	Hearing Equilibrium/balance
IX Glosso-pharyngeal	Pharyngeal muscles and parotid gland	Tactile and taste sensations from the posterior 1/3 of tongue, tonsils, pharynx and carotid sinuses
X Vagus	Heart, lungs, bronchi, and digestive tract	Sensations from the heart, lungs, bronchi, trachea, pharynx, digestive system & external ear
XI Spinal Accessory	Sternomastoid, trapezius, and constrictor muscles of pharynx, larynx, and soft palate	None
XII Hypoglossal	Strap muscles of neck and tongue muscles	None

Malignant Tumors

Gliomas are tumors of the neuroglia which comprise the non-nervous, supporting tissue of the brain derived chiefly from ectoderm. The most frequently occurring types are:

- **Astrocytoma** arises from glial cells known as astro- (star-shaped) cytes (cells). Glial cells (neuroglia), which may be either protoplasmic or fibrous, provide the connective tissue which binds together the neurons of the central nervous system. This tumor generally occurs in the cerebrum of adults and the cerebellum of children and is the most common type of glioma.
- **Glioblastoma** (multiforme) is derived from embryonal astrocytes and is sometimes called Grade IV astrocytoma. It is the most malignant of all brain tumors and occurs most frequently in adults arising in the cerebral hemispheres.
- **Oligodendroglioma** arises from glial cells known as oligo- (small, few) dendro- (branching) glia. These supporting cells are located as satellites about the nerve cells, between nerve fibers, and along blood vessels. These tumors occur most commonly in the cerebral hemispheres of adults.
- **Medulloblastoma** is composed of undifferentiated neuroepithelial cells. It is one of the most frequent gliomas of childhood and tends to occur at the midline of the cerebellum; in young adults it is found more often in the lateral lobes of the cerebellum. These tumors have a proclivity for intracranial or intraspinal metastases.
- **Ependymoma** arises from the ependymal cells which line the ventricles of the brain and the central canal of the spinal cord. It is found most often in the fourth ventricle occurring in children and young adults.

Nerve Sheath Tumors

- **Neurilemmoma** (neurinoma, schwannoma) arises from the neur- (nerve) (e)lemma (covering) which is the thin membrane covering the peripheral nerves, also called the sheath of Schwann. These tumors are usually benign, but may occasionally occur in a malignant form. In the cranial cavity, they frequently arise at the root of the VIIIth nerve (cerebellopontine angle) and are called acoustic neuromas.
- **Neurofibrosarcoma** is composed of interlacing bundles of anaplastic spindle-shaped cells which resemble those of nerve sheaths.

Neuroepitheliomatous neoplasms

- **Neuroblastoma** is derived from embryonic nerve tissue (neuroblasts) arising primarily in the autonomic nervous system and adrenal medulla, but not in the brain or spinal cord.
- **Meningiomas** arise in the meninges, the membranes that envelop the brain and spinal cord: the dura mater, pia mater and arachnoid. These are slow growing tumors and are most always benign. They are rare in children.

Benign Tumors

Benign tumors of the brain, while not invasive, do consume space and press upon vital tissues. These tumors are, thereby, potentially lethal, although they do allow for more prolonged survival than do malignant brain tumors. Consequently, tumor registries generally collect information on benign brain tumors as well as malignant brain tumors.

Some benign tumors are collected because they arise in the cranial vault, although they are not central nervous system (CNS) tumors.

- Hemangioblastoma is a hemangioma of the brain derived from blood vessel-forming cells (angioblasts).
- Cranio-pharyngioma is a tumor arising from embryonic cells of the cranio-pharyngeal canal (Rathke's pouch) and involving the pituitary gland. The tumor usually occurs in children.
- Chromophobe adenoma is a benign tumor of the anterior pituitary gland. It is associated with hypopituitarism and occurs mainly in adults.

06

Match each term on the left with one of the descriptions on the right.

- | | |
|--------------------------|---|
| _____ 1. Astrocytoma | a. Tumor of the membranes surrounding the brain and spinal cord |
| _____ 2. Neuroglia | b. The most common malignant brain tumor |
| _____ 3. Medulloblastoma | c. The most malignant of all brain tumors |
| _____ 4. Meningioma | d. Non-nervous tissue which supports the nerve cells |
| _____ 5. Glioblastoma | e. Tumor of the brain which is most common in the cerebellum of children. |

07

Which of the following are nerves of the autonomic nervous system?

- ☐ a. Sympathetic nerves
- ☐ b. Spinal nerves
- ☐ c. Cranial nerves

Answer: Q6

Match each term on the left with one of the descriptions on the right.

__b__ 1. Astrocytoma	The most common malignant brain tumor
__d__ 2. Neuroglia	Non-nervous tissue which supports the nerve cells
__e__ 3. Medulloblastoma	Tumor of the brain which is most common in the cerebellum of children
__a__ 4. Meningioma	Tumor of the membranes surrounding the brain and spinal cord
__c__ 5. Glioblastoma	The most malignant of all brain tumors

Answer: Q7

The sympathetic nerves are nerves of the autonomic nervous system

SECTION N
SENSE ORGANS

SECTION N

SENSE ORGANS

There are five major senses of the body: vision, taste, smell, hearing, and touch. The body, however, has literally millions of sense organs (or receptors), each associated with one or more nerves whose function is to convert the energy of a stimulus into a sensation or reflex. Receptors detect changes in our external and internal environment and initiate the responses necessary for adjusting the body to these changes. It is the dendrite portion of the sensory neuron which serves as the receptor of a sense organ.

Receptors may be classified according to their locations as follows:

Exteroceptors are surface receptors. They are located in the skin, mucosa, eye, and ear.

Visceroreceptors (interoceptors) are located in the walls of the blood vessels in the stomach, intestines, and various other organs.

Proprioceptors are located in muscles, tendons, joints, and the internal ear.

In this section, we will not cover all the body senses. Rather, the discussion will be restricted to the major senses of vision, taste, smell, and hearing.

Q1

What are the five major senses of the body?

1. _____
2. _____
3. _____
4. _____
5. _____

Q2

Match the receptors on the left with a location on the right.

<u>Receptors</u>	<u>Location</u>
_____ 1. Exteroceptors	a. Located in the walls of blood vessels in the stomach, intestines, and other organs
_____ 2. Proprioceptors	b. Located in the skin, mucosa, eye, and ear
_____ 3. Visceroceptors	c. Located in the muscles, tendons, joints, and the internal ear

Answer: Q1

The five major senses of the body are:

1. Vision
2. Hearing
3. Taste
4. Smell
5. Touch

Answer: Q2

- | | | |
|-------|--------------------|--|
| __b__ | 1. Exteroceptors: | Located in the skin, mucosa, eye, and ear |
| __c__ | 2. Proprioceptors: | Located in the muscles, tendons, joints, and the internal ear |
| __a__ | 3. Visceroceptors: | Located in the walls of blood vessels in the stomach, intestines, and other organs |

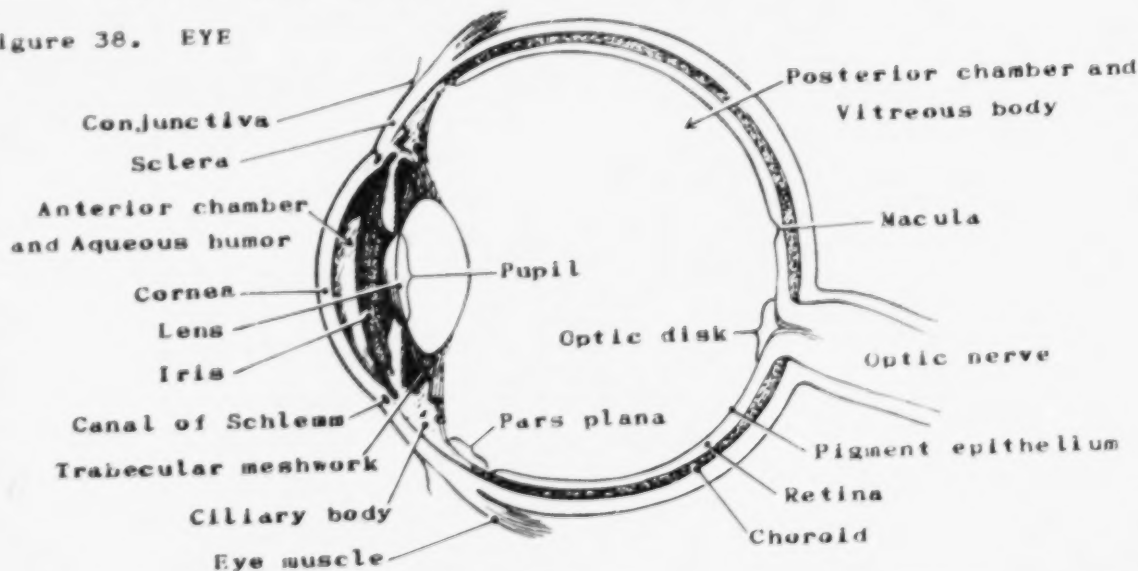
The Sense of Vision (Eye)

The eye is set in a bony socket, the orbit. The visible portion of the eye is covered by a thin transparent membrane called the conjunctiva.

The eyeball is not a solid sphere. It contains a large interior cavity that is divided into two parts, the anterior and posterior cavities. The anterior cavity, in turn, has two subdivisions known as the anterior chamber and the posterior chamber. Most of the eyeball (Figure 39) is recessed in the orbit, protected by the walls of this bony cavity. The wall of the eyeball is composed of three layers; from the outside to the inside, they are the sclera, the choroid, and the retina.

- The sclera, composed of tough fibrous tissue, is the protective and supportive layer of the eye. The anterior portion of the sclera, called the cornea, lies over the colored part of the eye (iris) and the pupil. The cornea is transparent and allows passage of light.
- The middle or choroid layer (the pigmented vascular coat) of the eye contains a great many blood vessels. The iris, the colored muscular ring, controls the size of the pupil and the amount of light entering the eye. The anterior portion is modified to form the ciliary body, the main part of which is ciliary muscle. Its function is the adjustment of the lens of the eye for vision at different distances. The crystalline lens is suspended from the inner surface of the ciliary body by circular ligaments called the suspensory ligaments. The function of the lens is to bend light rays in order to focus an image on the retina.
- The retina is the innermost layer of the eye. It is composed of two sections: the outer is pigmented and attached to the choroid layer, and the inner is composed of nervous tissue. The retina is the light sensitive layer.

Figure 38. EYE



conjunctiva--mucous membrane covering the anterior portion of the eyeball, and lining the eyelids.

Q3

What are the three layers which compose the wall of the eyeball?

1. _____
2. _____
3. _____

Q4

The retina is composed of _____ tissue.

Answer: Q3

The three layers which compose the eyeball are:

1. Sclera
2. Choroid
3. Retina

Answer: Q4

The retina is composed mainly of nervous tissue.

The accessory structures of the eye include the eyebrow, eyelashes, and eyelid. The eyebrow and eyelashes serve a protective function. The eyelid is lined with mucous membrane (called conjunctiva) which continues over the surface of the eyeball. The corner where the upper and lower eyelids join is called the canthus, the medial canthus being on the innerside, the lateral (temporal) canthus being on the outer side. The lacrimal apparatus consists of four structures: the lacrimal glands, lacrimal ducts, lacrimal sac, and nasolacrimal duct. These structures perform the functions of secreting and draining tears on the surface of the eyeball (Figures 39 and 40).

Figure 39. EYEBALL (Sagittal View)



Figure 40. EYEBALL (Frontal view)

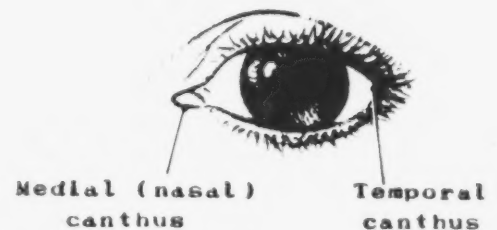
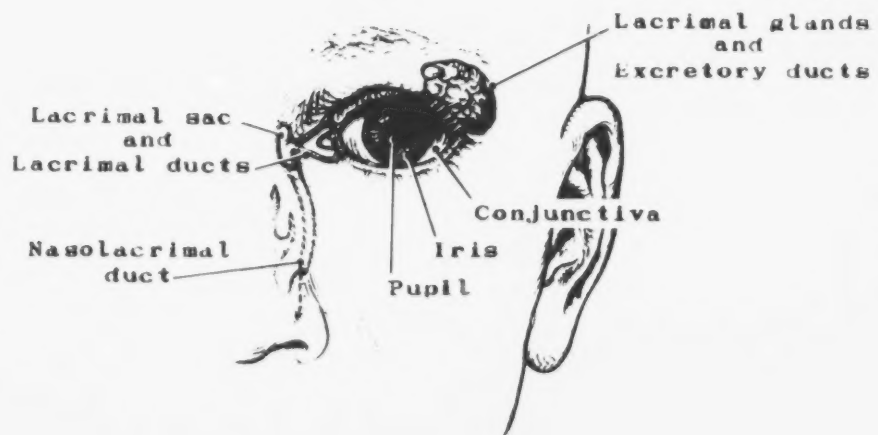


Figure 41. LACRIMAL APPARATUS



Q5

The eyeball is/is not a solid sphere. It is divided into two large -----.

Q6

The corner where the upper and lower eyelids meet is called the -----.

Q7

The ----- apparatus performs the function of secreting tears.

Answer: Q5

The eyeball is not a solid sphere. It is divided into two large cavities.

Answer: Q6

The corner where the upper and lower eyelids meet is called the canthus.

Answer: Q7

The lacrimal apparatus performs the function of secreting tears.

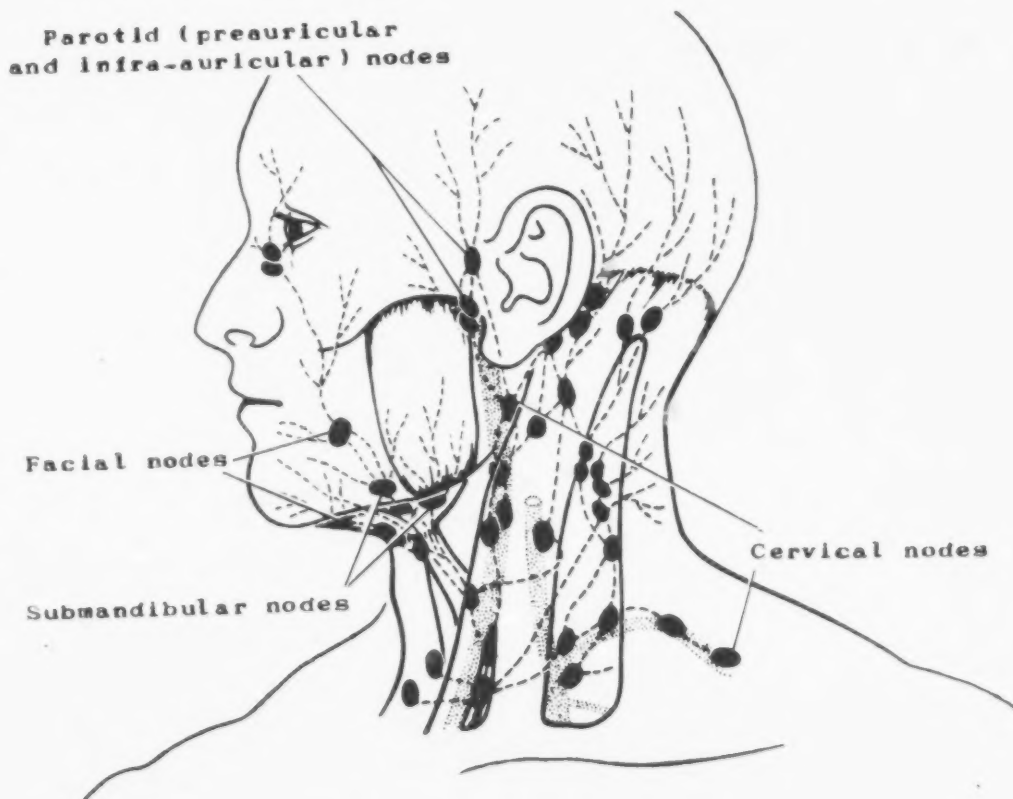
Regional Lymph Nodes

Much of the eye does not have true lymphatics, i.e., cornea, sclera, uveal tract, lens, retina, and orbit. The conjunctiva and the eyelid are drained by the submandibular, parotid (preauricular and infra-auricular), and cervical lymph nodes.

Malignant Tumors

- Malignant melanoma is the most common intraocular tumor.
- Retinoblastoma, a tumor arising from the retinal germ cells, is the most common intraocular neoplasm in children.
- Epidermoid carcinoma may arise from conjunctiva.

Figure 42. LYMPHATIC DRAINAGE OF THE HEAD (sense organs)



Q8

Name the lymph nodes which drain each of the following areas of the eye.

1. Cornea, sclera and lens: _____
2. Eyelid: _____, _____, _____ and _____.

Q9

The most common malignancy of the eye is _____

Q10

The most common eye malignancy in children is _____

Answer: Q8

The lymph nodes which drain each of the following areas of the eye are:

1. Cornea, sclera, and lens: no true lymphatics
2. Eyelid: submandibular, parotid, facial and cervical

Answer: Q9

The most common malignancy of the eye is malignant melanoma.

Answer: Q10

The most common eye malignancy in children is retinoblastoma.

The Sense of Taste (Gustatory Sense Organ)

Receptors for the sense of taste are known as taste buds. These are located on the tongue, palate, pharynx, and epiglottis. They are numerous on the tongue. Different taste receptors are stimulated by different kinds of substances. There are separate taste buds for sweet, sour, bitter, and salt substances (see Figure 43). All other qualities of experienced taste are a result of the fusion of two or more of the four primary tastes and as a result of the stimulation of the olfactory receptors. Therefore, the numerous tastes recognized are not taste alone but taste plus odors.

The four kinds of taste buds or corpuscles are not evenly distributed over the tongue. Most of those sensitive to bitter are located at the back of the tongue, those sensitive to sweet at the tip, and those sensitive to salt and sour along the sides and tip. (Refer to the Digestive System for the anatomy of the tongue.)

Regional Lymph Nodes

The regional lymph nodes for the anterior two-thirds of the tongue are only the sublingual and submental lymph nodes. The internal jugular (upper and lower deep cervical; jugulodigastric and jugulo-omohyoid) and submandibular (submaxillary) are regional for all parts of the tongue.

Malignant Tumors

Malignant lesions are more common on the anterior two-thirds than on the posterior one-third of the tongue. Squamous cell carcinomas constitute 90 percent of all malignant tumors of the tongue. The other 10 percent are made up primarily of lymphoepitheliomas and lymphosarcomas.

Lymphosarcomas will arise in the lymphoid tissue (lingual tonsils) found at the base of the tongue.

[Indicates a change from the 1986 publication including both the "upper" and "lower cervical" nodes in the "internal jugular" chain and calling them "jugulodigastric and jugulo-omohyoid" instead of "subdigastric and supraomohyoid" for consistency with the American Joint Committee on Cancer's Manual for Staging of Cancer, Third Edition.

Figure 43. TONGUE: Areas of taste



Q11

Receptors for the sense of taste called _____
are most numerous in the _____.

Q12

Separate receptors sense the tastes of _____, _____, _____,
and _____; but all other qualities of taste are a result of a fusion of
two or more primary tastes and the stimulation of the _____.

Answer: Q11

Receptors for the sense of taste called taste buds are most numerous in the tongue.

Answer: Q12

Separate receptors sense the tastes of sweet, sour, bitter, and salt, but all other qualities of taste are a result of a fusion of two or more primary tastes and the stimulation of the olfactory receptors.

The Sense of Smell (Olfactory Sense Organ)

The receptors for the sense of smell lie in the mucosa of the upper part of the nasal cavity. These receptors respond to chemical stimuli. Their location explains the necessity for sniffing or drawing air forcibly into the nose in order to smell delicate odors. The olfactory sense organs consist of hair cells which are extremely sensitive to stimulation by even very slight odors. However, they are also easily fatigued. This explains why odors that are at first very noticeable are not sensed at all after a short time.

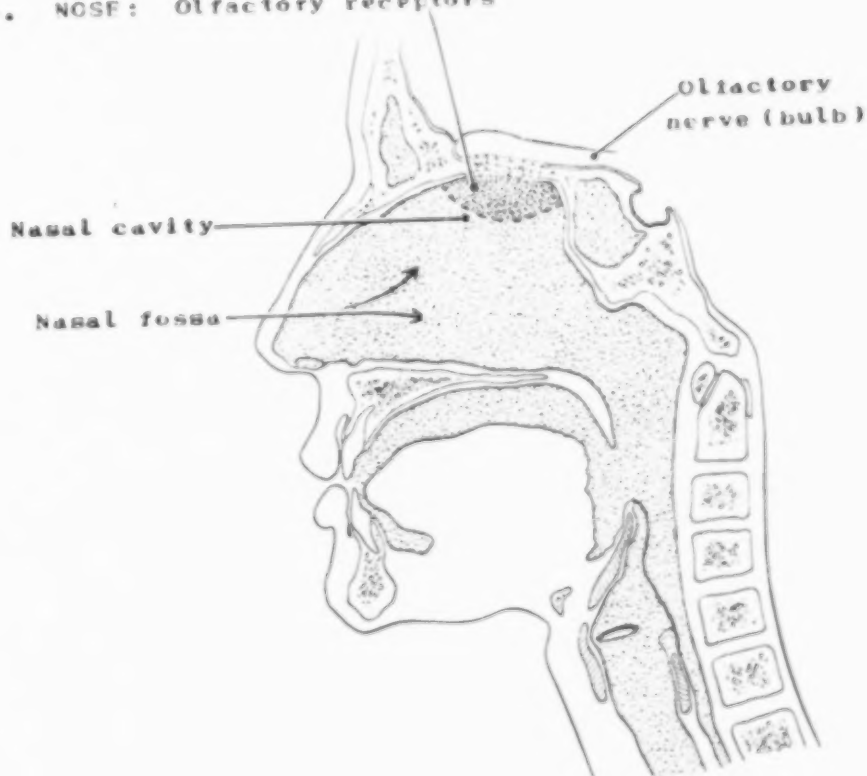
The term "nasal fossa" is the name for the entire nasal chamber. This chamber is divided physiologically into:

- A lower or respiratory portion of the nasal fossa
- An upper or olfactory portion of the nasal fossa. The term "nasal cavity" most properly belongs to this upper portion of the nasal fossa.

Regional Lymph Nodes

The lymphatic vessels from the nasal fossa enter the retropharyngeal, submandibular, and internal jugular (upper cervical) nodes.

Figure 44. NOSE: Olfactory receptors



Malignant Tumors

Tumors of the nasal fossa are rare. The most common type is squamous cell (epidermoid) carcinoma. Other types which occur less frequently are:

- Adenocarcinoma
- Adenoid cystic carcinoma
- Melanoma
- Lymphoma.

A malignant tumor known as esthesioneuroblastoma or esthesioneuroepithelioma, which arises in the olfactory nerve, will be found occasionally in the nasal cavities.

Q13

The nasal fossa is divided into a lower or _____ portion and an upper or _____ portion.

Q14

The receptors for the sense of smell lie in the mucosa of the _____ part of the _____ cavity.

Q15

The most common type of tumor in the nasal cavities is _____.

Answer: Q13

The nasal fossa is divided into a lower or respiratory portion and an upper or olfactory portion.

Answer: Q14

The receptors for the sense of smell lie in the mucosa of the upper part of the nasal cavity.

Answer: Q15

The most common type of tumor in the nasal cavities is squamous cell carcinoma.

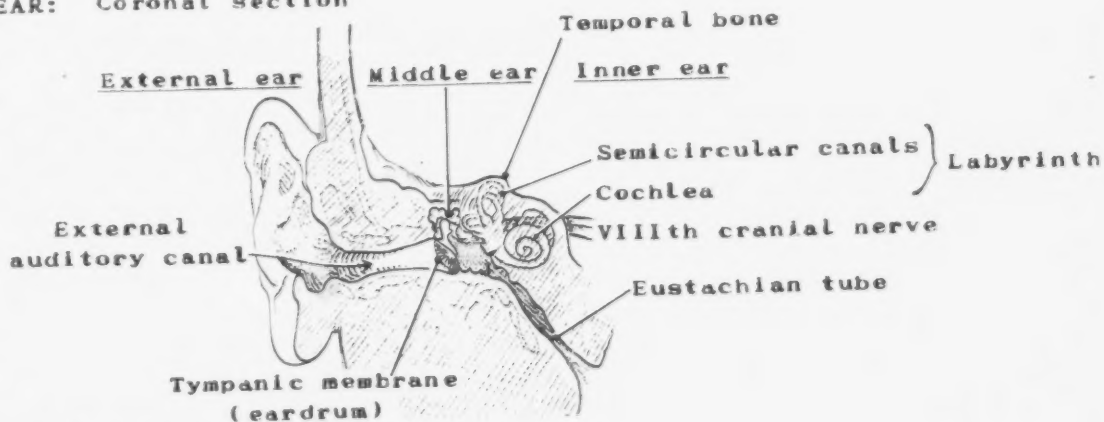
The Sense of Hearing (Ear)

The organ for hearing (see Figure 45) consists of three main parts: the external ear, the middle ear, and the inner ear.

- The external ear is made up of the pinna (or auricle) and the auditory canal. The pinna (pinna = wing) is made up of cartilage covered by skin. It collects the sound which is transmitted through the external auditory canal, leading to the tympanic membrane (or eardrum).
- The middle ear lies in a cavity in the temporal bone and is separated from the external ear by the tympanic membrane which transmits sounds to the internal ear. The middle ear is connected with the nasopharynx by the Eustachian tube. The function of the Eustachian tube is to equalize pressure on the eardrum. It opens when yawning or swallowing takes place.
- The inner ear is comprised of membranous tissue contained within a bony structure. The bony labyrinth has three divisions: the vestibule and two extensions of the vestibule called the cochlea and the semicircular canals. The cochlea is a spiral canal containing a receptor for hearing called the Organ of Corti. It has hair cells which pick up impulses transmitted from the inner ear.

The semicircular canals form the organ of balance. The superior, posterior, and lateral semicircular canals each connect by an ampulla (jug) to the utricle (a small sac), from which impulses travel to the brain by the vestibular branch of the VIIIth cranial nerve.

Figure 45. EAR: Coronal section



Regional Lymph Nodes

The lymphatics of the external and middle ear drain to parotid (preauricular and infra-auricular) lymph nodes. The middle ear lymphatics, in addition, drain to retropharyngeal nodes. Lymphatics from both parts of the ear go directly or indirectly to the internal jugular (upper cervical) nodes. The inner ear has no lymphatics.

Benign Tumors

Acoustic neuroma, a benign tumor of the auditory nerve, is the most common tumor of the ear.

Q16

Match the parts of the ear on the left with the descriptions on right.

- | | |
|-----------------------|--|
| _____ 1. External ear | a. Contains the receptors hearing |
| _____ 2. Middle ear | b. Made up of the auricle the auditory canal |
| _____ 3. Inner ear | c. Contains the opening of the Eustachian tube |

Answer: Q16

- | | | |
|----------|---------------|---|
| <u>b</u> | 1. External | Made up of the auricle and the auditory canal |
| <u>c</u> | 2. Middle ear | Contains the opening from the Eustachian tube |
| <u>a</u> | 3. Inner ear | Contains the receptors for hearing |

HISTOLOGIC TYPE/PRIMARY SITE

HISTOLOGIC TYPE/PRIMARY SITE

HISTOLOGIC TYPE	PRIMARY SITE
Squamous cell carcinoma	Oral and nasal cavities Pharynx and larynx Trachea, bronchus and lung Esophagus Cervix, vagina and vulva Anus and penis Skin
Adenocarcinoma	Stomach Small intestine Colon and rectum Pancreas and gallbladder Endometrium and endocervix Breast Prostate
Transitional cell carcinoma	Bladder and urethra Renal pelvis and ureters Anorectal junction (cloaca)
Hepatoma	Liver
Liver cell carcinoma	
Cholangiocarcinoma	Bile ducts (intrahepatic & extrahepatic)
Hypernephroma	Kidney parenchyma
Renal cell carcinoma	
Wilms' Tumor	

HISTOLOGIC TYPE	PRIMARY SITE
Seminoma	Testis
Dysgerminoma	Ovary
Cystadenocarcinoma	
Granulosa/theca cell carcinoma	
Liposarcoma	Adipose soft tissue
Fibrosarcoma	Fibrous soft tissue
Leiomyosarcoma	Smooth muscle, muscularis of organ wall
Rhabdomyosarcoma	Striated muscle, skeletal muscle
Mesothelial sarcoma	Pleura and peritoneum
Osteogenic sarcoma	Bone
Ewing's sarcoma	
Chondrosarcoma	Cartilage
Lymphosarcoma	Lymph nodes
Malignant lymphoma	and
Hodgkin's disease	
Reticulum cell sarcoma	Other aggregates of lymphoid tissue
Lymphangiosarcoma	Lymph vessels
Hemangiosarcoma	Blood vessels
Leukemias	Bone marrow
Multiple myeloma	
Astrocytoma	Brain
Glioblastoma multiforme	
Medulloblastoma	
Melanoma	Skin
	Eye

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UPDATING YOUR PRE-1989 BOOK 4, PART II, HUMAN ANATOMY AS RELATED TO TUMOR FORMATION

If you have an earlier version of Book 4, Part II, Human Anatomy as Related to Tumor Formation, don't throw it away. For consistency with the new American Joint Committee on Cancer's MANUAL FOR STAGING OF CANCER, Third Edition, simply make these changes.

Page 13, Kidneys, change "lateral caval" to "paracaval (lateral caval)" in the first paragraph. Also change the answer to Q8 on page 15 from "Lateral caval" to "Paracaval."

Page 21, Bladder, delete "Common iliac" from the regional nodes.

Page 25, Urethra, add "Common iliac" and "Inguinal" to regional nodes. Add "(hypogastric): Obturator" following "Internal iliac."

Page 40, Fallopian Tubes, add "Lateral sacral" to regional nodes.

Page 46, Answer: Q11, add "Lateral sacral" to the regional nodes draining the fallopian tubes and ovaries.

Page 48, Vagina, enter two headings which read "Upper two-thirds of vagina only" and "Pelvic nodes" over the "Common, External, and Internal iliac" and "Sacral" nodes. Enter another heading which reads "Lower one-third of vagina only" and under it enter the inguinal nodes:

"Superficial inguinal (femoral)

Deep inguinal: Rosenmuller's or Cloquet's node."

Page 58, Breast, delete "infraclavicular" from regional nodes under "High axillary" and add it to the last sentence of the text beginning "All other lymph node metastasis..."

Page 75, Prostate, delete "Superficial inguinal (femoral)."
Add "Periprostatic" and "Pelvic, NOS."

Page 83, Thyroid Gland, change the third entry under "The regional lymph nodes are..." which reads "Internal (upper deep)..." to read "Internal jugular (upper and lower deep cervical): jugulodigastric and jugulo-omohyoid" and change the last entry which reads "Upper cervical (including cervical, NOS)" to read "Cervical, NOS." Change "Anterior Mediastinum" to "Mediastinum."

Page 164, Tongue, change the second sentence under "Regional Lymph Nodes", which reads "The internal (upper deep)....." to read "The internal jugular (upper and lower deep cervical): jugulodigastric and jugulo-omohyoid and the submandibular (submaxillary) lymph nodes are regional for all parts of the tongue."